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Forest Service

ANNUAL REPORT OF

INTERMOUNTAIN FOREST & RANGE EXPERIMENT STATION

FOR 1939

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REPORT FOR THE CALENDAR YEAR 1939

INTERMOUNTAIN FOREST AND RANGE EXPERIMENT STATION

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March 15, 1940

REPORT OF THE INTERMOUNTAIN FOREST AND RANGE EXPERIMENT STATION FOR THE CALENDAR YEAR 1939

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PREFATORY NOTE

During the past year the research organization of the Intermountain Forest and Range Experiment Station, embracing the four divisions, forest management, range investigations, forest influences, and range economics, has made satisfactory progress. In addition to the accomplishments of specified work plans, representatives of the Station participated in a number of cooperative enterprises and meetings involving the welfare of wild lands. The adoption of Research results by Administration has continued with gratifying effects, especially in the fields of reseeding and erosion and flood control.

Certain outstanding accomplishments which are not described elsewhere in this report should be mentioned briefly here.

(1) Approval of a $22,000 State WPA "white-collar" project which has completed: (a) the tracing of some 1,650 quadrat-chart overlays, (b) the compilation into summary form of about 14,000 meteorological records from our branch stations, including thermograph records, general climatic observations, and rainfall-intensity records, and (c) the tabulation and summarization of some 16,500 Grazing Service and Forest Service grazing permits.

(2) Staging of a range seminar at the Great Basin Branch Station July 10-22, under Mr. Chapline's leadership. The meetings were attended by range researchers and range administrators from the western regions and the Washington Office, for the purpose of clarifying the objectives and coordinating the attack in range research.

(3) Development of a 4-acre site on the Cache National Forest near Mantua, Utah for the study of fundamental phases of the artificial revegetation project.

THE INTERMOUNTAIN AREA: A DYNAMIC, ECOLOGIC UNIT

The story of settlement and growth of the Intermountain region is one of the most stirring in the magnificent epic of American history. Here were none of the superficial characteristics of a land of promise. Rather, it seemed a land of denial. A bleak land of little rain, of hostile tribes, of locust plagues, of withering summer heat and bitter winters. A desert land where winning a living was - and is - a precarious job.

Were it not for the mountains the land would be desert yet. But the mountains with their water, their trees and grass and game, gave the settlers a foothold on the valleys. Paradoxically, the mountains and wild lands made civilization possible. For the task here was not one of man's subduing nature, inimical as nature may have seemed to the pioneers, not one of overthrowing the environment, but of fitting into it and becoming part of it. That is why we have called the Intermountain area "an ecologic unit." Here man, to maintain his precarious position, is forced into alert and active cooperation with nature.

Neither nature nor man is static; all is growth, development, change. Problems arise and are settled, but the work is never done, for still newer problems constantly arise.

Times have changed and times are changing: men need water now even more than they needed it in pioneer days, for there are more crops to be grown and more men to be fed. But, though the snows lie just as deep the quality of stream flow is changing: a greater part of it runs off the mountain slopes in early spring, and when the drought months of summer come, the streams are shriveled.

Men still need timber and fuel, but so much timberland is now unproductive that they must import timber where they might be growing their own.

Men need meat and wool and leather. Wild game was inadequate and uncertain in the changing times, and men quickly became dependent on flocks and herds. But the grass is scanty where once it was luxuriant, and although men need more sheep and cattle now, less can find grazing.

These things go back to the soil. The soil, too, has changed, is changing. Because of burning and unwise cutting of forests, unwise grazing of ranges, soil has washed away. What remains is less effective in storing water and feeding streams, less effective in growing trees and the better kinds of forage.

Men need water, food, and shelter in the old ways, and in new ways too. Their needs are daily greater, not less. For men themselves change. Now they have grown in numbers; the desires of one jostle the liberties of another, interests conflict, competition for livelihood becomes increasingly keen. We have the new technology, altering the relations of man to man and of man to nature.

The new technology gives new significance to the mountains through its influence upon man. In his cities it has brought monotony to his tasks, fastened him to an environment of concrete, steel, noise, and foul air. In striving to impose mechanical perfection upon him, it has plagued and sickened him with nerve tensions and emotional stresses. Now he turns to the mountains for respite and peace, a taste of the simple life, a chance to recreate himself. He finds the mountains an escape from too much civilization, as they have long been an escape from the excessive heat of summer.

Part of the service which it is this Station's job to perform in the resource management of the Intermountain region, is to recognize these ecological trends and changes, define the new problems, and attack and solve them.

In our last annual report, economic problems of range use were outlined. In the two annual reports before that, the research achievements and the broad problems of forests, ranges, and watersheds of this region were discussed. The attack upon these problems is being continued and is outlined in the status sheets.

It is the object of this general section to describe specific problems -- the silvical problems of lodgepole pine, the range problems of big game and of cheatgrass, and the problem of forest recreation -- which heretofore have received little notice. The Wasatch Stream Flow Laboratory is described with its bearing upon the relationships between watersheds and people. These problems, in this dynamic environment of which man himself is so intimate a part, have been increasingly thrust to the fore of late years and are in urgent need of serious attention from research.

THE WASATCH STREAM FLOW LABORATORY

Significance of Intermountain Watersheds

Much of the Intermountain West is made up of semidesert valleys separated by high mountain ranges. The accumulation of snow on these mountains provides the water needed by farms and communities in the lowlands, for the light summer rainfall of this arid region is insufficient to grow crops. Some of the water from melting snow runs off in May and June; some sinks into the mountainsides to reappear as stream flow later in the summer. This water yielded by the mountains is the basis of the cultural development that now exists in the arid valleys of the West. Stream flow is vital: it is the umbilical cord by which the lowlands are nourished.

The relationship may be illustrated by considering the situation in the State of Utah. In Utah the greatest part of the water for agricultural, industrial, and domestic needs originates on about 10 million acres of land above 7,000 feet elevation. The amount diverted each year for use on 1,324,000 acres of agricultural land is approximately 4 million acre-feet. Thus the water yield from 7.5 acres of mountain land makes possible the intensive use of 1 acre of valley land. At the modest value of $3.00 per acre-foot, this water has a yearly value of $12,000,000 or a capital value of $200,000,000 for crop production alone. Some of the water, as it flows down to the lowlands, is passed through hydroelectric plants. These supply over 90 percent of the electrical energy used in the State.

Before man settled the Intermountain region the streams had definite characteristics of flow, the resultant of such factors and forces as the climate, the topography, the geology, and the soil and plant mantle, all of which had been operating through the ages. During the process of developing western irrigation agriculture, man has dammed the streams, constructed elaborate diversion work, dug mine shafts, cut timber, grazed flocks and constructed spiralling roads to upland areas. In so doing he has tampered with the long established physical and biological laws governing watershed lands and thereby altered the flow characteristics of mountain streams.

At the present time these laws are little understood, influenced as they are by the interactions of climate, topography, geology, physical and chemical characteristics of soils, plant cover, and the utilization of the watershed resources. Popular consciousness of the importance of water has not extended much above the headgate. But economic and social repercussions arising out of this narrow perspective now make it imperative that we look beyond the headgate, lateral, and reservoir to the mountain lands from which stream flow comes, and to the natural laws that govern the whole process of water accumulation, infiltration, and discharge. Man cannot expect to maintain mastery over his vast watershed domain, and in particular its valuable stream flow, without comprehensive knowledge of the factors that determine amount and especially seasonal distribution of flow.

Research at the Wasatch Stream Flow Laboratory

If it were possible and desirable to use the mountain lands only as watersheds the problem would be far less difficult than it is. But the mountains have resources in forage, timber, game, and recreation as well as in water. All these resources -- not one to the exclusion of others -- should be utilized to the fullest degree. This is the well-recognized concept of multiple use, a concept which is indeed a challenge to man's ability to evaluate the factors with which he is dealing and to his skill in applying them effectively in watershed management. It is a challenge which requires that guesswork must give way to knowledge secured by prosecution of a sound and meticulous research program.

Such a research program is being established on typical watershed lands in northern Utah, designated the Wasatch Stream Flow Laboratory. Here the following factors considered to represent minimum requirements in understanding the water cycle will be given emphasis: (1) climatic factors including snow melting phenomena, (2) water lost to vegetation, using a limited number of major types, (3) phenomena of overland and shallow seepage flow, (4) phenomena of infiltration to, and yield from deep seepage channels, (5) effect of elevation on stream flow, (6) effect of aspect on stream flow, and (7) effects of utilization of other mountain resources on these water cycle phenomena.

Three groups of watersheds will be equipped for study: (a) Six north-facing watersheds, comprising about 840 acres in aspen-fir and woodland types; (b) five south-facing watersheds directly opposite, comprising about 1,400 acres in brushy and herbaceous types; and (c) two west-facing watersheds, one of 1,400 and the other of 2,000 acres. By July 1, 1940 the watersheds will be served by 4 physical factor stations tied into 86 standard rain gages and 46 yearlong snow and rain gages.

North- and south-facing watersheds are or will be equipped with Venturi-trapezoidal flumes and automatic waterstage recorders, soil-moisture sampling pits designed to show the movement of free and capillary water yearlong through the root zone, *in situ* lysimeters (plots) for measurement of water-consumption by major vegetal types, and about 2,000 permanent sample plots for periodic records of vegetation, litter, and soil. The flow of Farmington Creek, to which the north- and south-facing watersheds are tributary, is under automatic measurement.

The west-facing watersheds, drained by Parrish and Centerville Creeks, will have synchronized, automatic stream flow recorders at each 1,000 feet of elevation and also on 16 surface run-off plots in aspen, browse, and weed types. These installations are designed to yield information on the relation of elevation and plant cover types to water accumulation and stream flow.

Headquarters of the Wasatch Stream Flow Laboratory are at Farmington, Utah, with substations at the head of Parrish Creek near the south end, and in Farmington Canyon near the north end of the experimental lands. The establishment of this forest influences research center for the Great Basin which began in 1934 will be about 80 percent complete on July 1, 1940. Funds for construction have come largely through WPA grants with some CCC assistance.

Clearly the physical plant of the Wasatch Stream Flow Laboratory is of great potential research value. Operation of completed phases has so far been carried out with selected WPA employees who unfortunately work only on a part-time basis. The Laboratory's greatest need is the assignment to specific study phases of properly qualified, full-time research personnel.

THE PROBLEM OF LODGEPOLE PINE

Significance of Lodgepole Pine

Of the Intermountain region's 25 million acres of forest land some 16 million are considered commercially important, including about 4 million acres of lodgepole pine. Thus, lodgepole pine forests occupy about 16 percent of the total forested land area, and make up 25 percent of the commercially important forests in the region. On the national forests alone it is estimated that lodgepole pine saw-timber volume exceeds 9 billion board feet, and that the volume in pole stands (trees 4 to 12 inches in diameter) is equivalent to at least 10 billion board feet. In area and volume it therefore surpasses any other single species and occupies the most significant place in the forest economy of the region.

The lodgepole pine forests contribute in several ways to the welfare of Intermountain people, particularly the rural population.

First, there is "free use." During the last decade some 25,000 permittees have removed about 50 million board feet of dead and down lodgepole from the national forests each year. The amounts removed from private holdings, State and Indian lands, and public domain are not known but they also must be fairly large. Fuel, fence posts, and poles for construction are secured by farmers, ranchers, and other residents, largely through the provision of "free use", and without question this counts large in the comfort and economic well-being of a significant portion of the rural population.

Second, lodgepole pine provides raw material for numerous sawmills and for operations cutting ties, poles, and mine timbers. The miscellaneous uses of lodgepole pine (including fence material and fuel) account for a larger volume in the aggregate than lumber, but its use for lumber is also important locally. At the present time in Region 4 there are some 350 mills, each producing at least 50,000 board feet of lumber per year. In addition, there are a number of smaller establishments operating sporadically as supplementary enterprises. Many of the mills produce lumber in isolated communities, and do not enter in competition with national markets. All of them meet local needs, and both by giving employment to thousands of local inhabitants and by manufacturing suitable products vended locally at nominal prices, do much to maintain standards of living in rural communities.

In the last 10 years commercial sales and sales at cost of lodgepole pine timber on national forests have amounted annually to about 20 million board feet, with average stumpage receipts of $40,000 per annum. Total production of lumber alone, in the same period, has amounted to over 120 million board feet with a mill value of about $2,000,000. Under intensive forestry, it is estimated that these forests could yield an average of 750 million board feet per year - about 30 times the present annual cut of green timber! Hence the future may see a large expansion in the lodgepole pine timber business.

The third contribution of the lodgepole pine forests is that of safeguarding recreational and watershed functions of the lands within the forest type, while retaining the lands in the highest form of use. For the present at least, the highest form of use of these lands appears to be timber production; and except on local areas all the associated values such as recreation, watershed protection, and wildlife could be simultaneously realized if proper systems of timber management were known and effected.

Specific Problems

It may be questioned whether past studies of lodgepole pine might not provide sufficient information for present purposes in this region. Although several investigations have been made in other regions and their results published, most of the information does not apply directly to the acute problems now confronted here. Some of the basic facts on silvical characteristics, tree volumes, and tree classification may be and are being applied, but even these need local checking. And some recommended practices used successfully elsewhere have failed when applied in the Intermountain region. A few studies, chiefly in the form of sample plots, have been undertaken by administrative officers within this region, but lacking in centralized planning and direction, in scope, and often in systematic continuation, they are of limited value at best. The extensive range of lodgepole pine, and the concomitant wide variation in climate, in soils, and in associated species, necessitate distinct regional studies of the type.

At present most of the questions relating to lodgepole pine are within the field of silviculture, particularly the principles and practices governing cutting in this type.

The problems do not result entirely from defects in past cutting practice. Far more serious than drain from actual cutting has been the tremendous toll taken by insects. During the last two decades, barkbeetles have destroyed entire stands or at least the merchantable portions of stands over thousands of acres. The epidemic has now practically run its course, so that problems of the future are, on the one hand, the determination of management practices applicable to the depleted remnant stands where losses have occurred, and on the other hand the determination of practices, such as the reservation of resistant types of trees, that will minimize further barkbeetle damage.

Two problems in the harvesting of present timber crops are particularly pressing: (1) that of obtaining adequate natural regeneration, and (2) that of obtaining satisfactory growth in residual stands. Contrary to the belief of many, there are numerous examples of failure of lodgepole pine to reproduce itself on cut-over areas. In part of western Wyoming, for example, where lodgepole pine is associated with other species in a tension zone, the understory and ground cover of scrubby alpine fir seem to prevent satisfactory establishment of lodgepole seedlings. Again, residual stands left after commercial cuttings or as a result of heavy losses from windfall and insects have seldom shown the rapid rates of growth which might be expected or desired. The development of silvicultural systems that will be economically feasible and at the same time insure good growth, result in minimum losses, and provide seedbed conditions favorable to regeneration is a complex job that is a real challenge to research.

With a good demand for fuelwood and for poles of all sizes in many localities, lodgepole pine offers one of the best opportunities for thinnings and improvement cuttings of any type in the region. Other practices such as pruning or weeding may be feasible in certain cases. Such stand improvement work is largely self-liquidating and provides an immense work reservoir for the employment of CCC or relief labor. But to insure that the work will be conducted efficiently and with greatest benefit to the forest in the long run, research into methods and principles is needed.

All phases of these problems cannot be solved by simple trial tests, however well designed and executed. There is need for fundamental knowledge of the silvics of the species - all aspects of its physical and physiological behavior under the wide variety of environmental conditions to which it is subjected. Studies of such problems can often be worked out in conjunction with "practical experiments", but must not be overlooked in any comprehensive research program.

Forest management research by the Intermountain Station during the last 10 years has been confined almost entirely to the ponderosa pine type. This limitation has been imposed by lack of funds rather than lack of problems or interest in other types. Questions relating not only to lodgepole pine but also to Douglas fir, white fir, spruce, and other forest types are constantly arising but have to be left unanswered. It has not seemed wise to try to divert to these types any of the very limited research effort being devoted to ponderosa pine. What is needed is the initiation of a major study of lodgepole pine, with adequate finances, personnel, and facilities to function effectively and independently.

TWO IMPORTANT RANGE PROBLEMS

Range problems of the Intermountain region are now being attacked on three fronts -- high-mountain summer range, intermediate spring-fall range, and desert winter range. The attacks naturally center around the relationships between livestock and forage. Just as these research efforts are the result of problems which arose in the past -- part of the continual process of change -- so now newer problems have reached an importance that demands serious attention from Research. Two broad problems have come to the fore which are somewhat more specialized than the three major fields of attack but which affect them all. These are the problems of big-game ranges and cheatgrass.

THE BIG-GAME RANGE PROBLEM

Significance of Big Game

A healthy, balanced population of game is a valuable resource in the Intermountain region. The presence of big game as well as a variety of smaller forest animals and birds, coupled with the accessibility of the national forests to the public, provides delight for thousands. According to the last annual report of the Chief, national forests of this region contain 35 percent of the mountain sheep, 34 percent of the moose, 31 percent of the antelope, 25 percent of the elk, 12 percent of the deer, 8 percent of the mountain goats, and 7 percent of the bear of all the national forests. The pleasures of observation and hunting are enjoyed not only by Intermountain people, but attract numbers from outside the region.

The presence of these game animals is an important economic asset as well as a social asset to Intermountain communities. Expenditures by sportsmen, both local residents and outsiders, mount to sizable sums each year, and for thousands of farmers, ranchers, and dwellers in small rural communities where cash income is all too meager, a supplement of wild game to the larder has real economic significance.

Although the wildlife resource is valuable, it must not get out of balance with other resources. In fact, the essential problem may be boiled down to the determination and maintenance of a working balance. That there is a problem is indicated by lack of balance at the present time.

Since 1920 the estimated game numbers in Idaho have increased from 43,000 to 151,000; in Utah from 13,000 to 206,000; and in Nevada from 2,000 to 67,000. About 75 percent of these animals are on the national forests of the region. The increase in numbers need not in itself create a problem. The problem is principally one of unequal distribution. While many areas might well support more game animals than they do, many others now suffer from a congestion of big game, particularly deer and elk.

The Fishlake National Forest provides an example. Practically the whole west side of the forest is suffering from overutilization of the browse species eaten in common by deer and sheep. In certain areas aspen reproduction has been grazed off repeatedly, and under continuation of such use the time may be foreseen when stands of this short-lived species will be eliminated. Aspen sites will then support only species unpalatable to deer and livestock, and probably, with the invasion of coarse brush or undesirable weeds, watershed values will be greatly impaired. On the lower parts of the forest now used for winter range shortage of feed is already so critical that the animals congregate on private grazing lands and nearby ranches.

Although the Fishlake Forest presents the problem of over-utilization in its most acute form, the problem occurs on areas throughout the region. The welfare of the animals themselves, as well as the welfare of associated forest resources, is imperiled.

Owners of domestic livestock with permits on the national forests naturally resent and resist having their permits reduced either for "distribution" or for "protection" when deer or elk, depending on the locality, are increasing rapidly in numbers. They argue that any forage they save by reduction is immediately taken by big game. Thus the inadequately developed system of game management in operation is an almost insurmountable barrier to getting the adjustments in domestic livestock necessary for range and watershed protection.

Under the leadership of the Forest Service and the State Game Commission, a big-game committee has been set up. This committee has been able to make but little progress, however, in spite of earnest effort, because although there is no lack of opinion and prejudice on every controversial point connected with game range, very few real facts are known. It is now recognized by livestock associations and sportsmen's organizations as well as by forest officers that there must be a more substantial fund of information from which to work. Although the deer populations of some areas in Utah have been reduced by temporary revision of the hunting laws, this device must be regarded more as an expedient than as a real remedy. A real remedy can result only from more comprehensive, foresighted measures of control. Adequate game management coordinated with other phases of resource management cannot be secured without whole blocks of new data, and these can be obtained only by careful research.

Research Needed

Thorough-going studies are needed in the following phases of the use of grazing land by game:

1. Over-all range surveys of ranger districts where game population is excessive. Knowledge both of the location of these areas and the nature and degree of utilization is necessary to provide a comprehensive picture of conditions and to define ecological trends in plant cover.

2. Determination of proper-use factors of major forage species for game as well as livestock. The most reliable information at present, from about 200 stomach analyses, is not related to a knowledge of the kinds of forage available to the deer, and hence probably fails to reflect true forage preference. To accumulate the needed information hundreds and perhaps thousands of observations must be made for big game such as have been made for sheep in working out proper-use factors of forage species at the Desert Branch Station.

3. Determination of the degree of utilization that the major forage species can withstand.

4. Determination of the degree to which heavy use of particular browse species by deer affects the condition and abundance of other forage. How much the weakening or destruction of certain species that are highly preferred by deer will expose the topsoil to injury is not known.

5. Economics of livestock and game production. Much study will be required in order to equate the returns from game and livestock utilizing the forage jointly under varying intensities of total use. It will also be required to determine the relative returns from ranges largely utilized by game on the one hand and by livestock on the other.

6. Evaluation of the problems of common use. Where neither deer nor domestic stock graze heavily there is so much diversity in their forage preferences that conflict is avoided. As the intensity of grazing increases and the preferred forages become scarcer, both deer and domestic livestock graze certain species more and more in common. The location of a point where the overlap in utilization is not so intense as to cause severe injury to important forage species must be achieved.

Some administrative funds have made possible the selection of an area near Fillmore, Utah on the lower edge of the Fishlake Forest, suitable for some of the studies most urgently needed. A boundary fence tight to livestock and deer is being constructed to enclose a 750-acre pasture which is suitable for yearlong deer grazing. One part of this pasture suitable for winter range will be separated from that suitable for summer use by a partition fence. A preliminary inventory was made last fall on borrowed time, in order to obtain a general idea of the condition of the vegetation.

Research funds of about $20,000 annually are required to complete the experimental facilities and to initiate the research program. A system of enclosures will be devised to provide for: (a) protection of the vegetation from both deer and livestock, (b) use by deer but not by livestock, (c) use by livestock but not by deer, and (d) common use by deer and livestock. Extent of forage utilization by rodents must also be measured, as well as the degree of competition among livestock, game, and rodents. No research funds in the Intermountain region are now available for this study, but if they could be made available would contribute to the solution of a problem of high importance to livestock growers, sportsmen, land-managing agencies, and general public welfare.

THE CHEATGRASS PROBLEM

Significance of Cheatgrass

Although there is much debate concerning the probable condition of the Intermountain ranges at the time of settlement, it is certain that the pioneers found no evidence of cheatgrass when they entered Salt Lake Valley. This grass, also known as "downy chess", is a winter annual, native to south-central Europe, which found its way to the Intermountain region about the turn of the century. It spread rapidly during the first decade into openings made by thinning the native plant cover as a result of burning and severe grazing. Abandonment of plowed lands, once thought suitable for dry farming, has also been a potent cause for the extensive replacement of native species by cheatgrass. As a result of these factors cheatgrass has become one of the most conspicuous range plants in the region.

Cheatgrass grows most commonly in the foothill zone on spring-fall ranges. Probably the factors of overgrazing and burning that first weakened the native range plants enough to permit the firm establishment of cheatgrass are still aiding it, by reducing the vigor of many desirable native species, in maintaining an important place in our flora.

Seeds of cheatgrass usually germinate in the fall, so that, in occasional years, fall growth provides a significant amount of feed. Growth is rapid in the spring and by June the plants have matured seed and dried. Upon curing, the seeds develop hard, sharp points, and the palatability of the species declines rapidly. The chief value of cheatgrass for forage is therefore confined to a short period in spring, and, in unusually favorable years, to a few weeks in the fall.

Not only the length of period during which cheatgrass is palatable, but also the total amount of feed produced varies greatly from year to year. Preliminary studies have shown forage production on small plots in cheatgrass range to vary more than elevenfold from one year to the next as a result of climatic differences, while forage production on similar plots in perennial grass range varied less than twofold during the same period. During especially unfavorable years cheatgrass makes so little growth that its forage production is practically negligible. Stockmen who depend on this species for much of their spring feed are hard pressed during such years.

This species has other undesirable qualities. It constitutes a serious fire hazard and each year it is largely responsible for carrying fire through thousands of acres of foothill range lands. The value and palatability of hay, especially late-cut hay, is considerably reduced by the presence of cheatgrass in any appreciable quantity. Mechanical injury to the mouths of livestock, especially sheep, results from the hard, sharp points of its mature seeds. The likelihood that the presence of cheatgrass hinders both natural and artificial revegetation of more valuable species is of great significance in a program of range improvement. The rapid dissipation of soil moisture by its early spring growth is frequently the cause for failure of perennial grass seedlings to establish themselves.

These characteristics of cheatgrass, but primarily the short season during which it can be used and its uncertain forage production from year to year, make it an extremely undesirable plant on which to base an enduring and stable range livestock industry. Paradoxically, there can be little question but that the livestock industry now finds cheatgrass very valuable. This is to say, if this grass were destroyed, there would be little or nothing to replace it, and certainly cheatgrass is much better than nothing at all. It is effective in checking soil erosion, though less effective than perennial grasses; and it provides forage at a time of year when forage is most badly needed. In fact the foothill spring-fall ranges, because they are of such limited area and carrying capacity, form the bottleneck of the range livestock industry. The problem, then, is not one of destroying cheatgrass, but one of replacing it with something better, and thus of widening this bottleneck so as to permit more flexible adjustment in season of use of all range lands.

Research Needed

Range improvement measures should be planned in cognizance of the established needs of livestock operators. Thus, since the need on most areas now occupied by cheatgrass is for a greatly increased and a more dependable source of spring-fall feed, only perennial species that make early spring growth, even in years with unfavorable climatic conditions, and that either cure well or provide ample fall regrowth, should be encouraged to replace cheatgrass.

The considerations of the foregoing pages lead to the following recommendations for a research program into the problem of replacing this by more valuable forage species.

1. Study of the life-history of cheatgrass in detail by means of careful ecological and physiological researches. Is the species still spreading, or has it reached the limits of its distribution? It is of special importance to understand the reactions of cheatgrass to various physical sites and to associated species, and the reactions of associated species to it.

2. Determination of the feasibility of increasing the proportions of perennial species in mixed stands not yet completely dominated by cheatgrass, through appropriate methods of range management. This will probably require extensive pasture tests conducted on a practical basis.

3. Determination of the feasibility of increasing forage production through artificial revegetation. Where cheatgrass is the principal species, artificial reseeding to more valuable species may prove to be the most effective means of improvement. Enough work has been done to indicate that under certain conditions which are not yet fully determined, crested wheatgrass and bulbous bluegrass can be seeded successfully in thick stands of cheat. However, much more experimentation is needed, both to find additional adapted species of high value to the stockman, and to devise effective low-cost methods of planting. Finally, some fairly large areas should be reseeded in order that satisfactory methods of management of reseeded ranges may be ascertained and the practical value of such rehabilitation may be demonstrated.

4. Determination of the pathology of cheatgrass attacked by smut. It is known that epidemics of smut occasionally almost kill out extensive areas of cheatgrass, but the basic causes are not yet understood. The possibility of using smut as an aid to positive methods of range improvement should be investigated. For example, the use of smut may provide a means of reducing the vigor of cheatgrass at the time artificial reseeding of perennial species is attempted.

THE PROBLEM OF FOREST RECREATION

Significance of Forest Recreation

Although wild lands for ages have supplied economic needs, it is only in recent years that we find great numbers of people turning to them in response to the noneconomic need of recreation. Wild lands, especially the forests, have been discovered to be a resource something like that fabled fountain sought by Ponce de Leon, capable of "re-creating" body, mind, and spirit. In consequence the forester's job has expanded to include responsibility for this new resource along with the economic resources which he has long administered.

According to the annual reports of the Chief, recreational visitors to the national forests have numbered approximately as follows (in millions):*

	1912	1918	1928	1938
Total visitors	2	3	23	115
Participant users	2	3	6½	14½

Two trends are apparent. One is a stupendous increase in numbers. The number of participant users alone doubled during the decade 1918-28 and doubled again during the decade 1928-38. The other trend is an increasing proportion of a type of visitor almost unknown 20 years ago -- the spectator type. We know of still more trends in use, as yet unmeasured, such as the wilderness movement, winter sports, and group forest recreation.

How these trends will alter in the future is not known. There seems little reason to think they will go downward, so long as our present social structure continues.

It is well known that many forest areas intensively used for recreation have already deteriorated to the point of abandonment, and that others are progressively declining in recreational value. Alert administrators responsible for forest recreation are conscious of the need for more adequate means of coping with this problem. The devising of more adequate means will require a knowledge of more facts.

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* "Total visitors" includes, in addition to "participant users", "spectators" -- sightseers, whether automobilists, hikers, or horseback riders, and those passing through the forests enroute elsewhere. "Participant users" includes (in order of numbers) picnickers, campers, hotel and resort guests, and summer-home permittees and guests.

For example, the administrator needs to know that the recreation resource is renewing itself as it should. He needs to know how to rehabilitate potentially valuable but depleted areas. He needs an accurate means of predicting trends: what may he expect in the way of a swing toward participant use by the present 90 percent of visitors who are spectators? To quote the Copeland Report (p. 30): "One phase of the problem is to anticipate the full range and volume of needs and possibilities." How should the administrator plan for adequate picnic areas, campgrounds, wildernesses?

Because the national forests of the Intermountain region are bound so closely to the economic welfare of the people, and because a large part of the Intermountain population is rural, there is some tendency to overlook the forests' esthetic, social, and recreational value. Actually, because of their proximity to semidesert valleys, their accessibility, their beauty, their wildernesses, their fish and game, and their desirability for winter sports, the noneconomic value of these national forests is very high. And they are used: of the 14½ million participant recreationists which used the national forests in F. Y. 1938, 1¼ million were reported from Utah alone, second only to the number from California. The national forests of Utah comprise only 4.4 percent of the total national forest area, but they accommodate 8.7 percent of the participant recreationists.

While the forests of the Intermountain region do not embrace all the problems of forest recreation in its national sense, they do include a wide variety. Here the vegetal resource, comparable to that of much of the West, is possibly in a more precarious balance with its environment than is the vegetation of more humid regions. The problems of measuring use intensity, trends in demand and trends in vegetal behavior under use, are probably as typical of the West as any one region can provide.

Development of a progressive recreational program has additional significance to the Intermountain region in view of the close relationship between the welfare of its human population and the welfare of its forest lands. By means of forest recreation, in which they already have a genuine interest, it may be hoped the people can come to know their forests better. As a result of intimate, first-hand knowledge we may look forward to increased public appreciation of the forests, and of all the interrelated resources that lie in them.

Objectives of a Recreation Research Program

A research program should be aimed, first, to provide the administrator of forest recreation with facts, and from analysis of facts by both the research man and the administrator, to arrive, secondly, at principles of management. The following specific objectives may not take all needs into account, but they embrace some of the most urgent ones. Further knowledge will undoubtedly reveal additional problems of forest recreation in need of intensive study.

1. Accurate estimates of current use. Beside serving the needs of a reliable census, a degree of accuracy is needed in these estimates which will permit prediction of amounts and kinds of future use. Implicit qualities of such estimates are freedom from bias, and knowledge of the limits of sampling error. In order to arrive at sufficiently accurate estimates it is first necessary to evolve sampling procedures based on the best modern biometric principles.

2. Measurement of effects of use on vegetation. Some sites and some species are apparently more adversely affected than others by the concentration of people. To understand why this should be so, it is necessary to measure the physical impact of people on various plant communities, as to effect both on the vegetation directly and upon the environment. From such studies may be derived means of revegetation, either natural (such as, for example, might be accomplished by rotational campground use), or artificial, and consequent suggestions for improved methods of management. The problems of roadside ecology and the factors involved in the preservation of strips of forest to maintain the scenic values of forest roads may also be included under this heading. Two particularly urgent requirements are the means of knowing the nature of changes in vegetal cover that are taking place, and the rates of change.

3. Determination of needs of forest visitors. In order to correlate the various phases of resource management it is, of course, essential to learn on the best possible factual grounds what recreational resources are needed now and are likely to be required in the future. The forest administrator also needs to know what degrees of campground development combine the highest sum of desirability and practicability.

4. Measurement of economic and social values. While most of the value of recreation to forest visitors is incapable of expression in terms of hard cash, there is still a considerable economic return to the country as a whole resulting from enhanced physical, mental, and moral health. To communities near the forests expenditures by visitors are an economic return comparable to direct returns from tangible forest resources. Measurement of these economic values is

highly desirable. Desirable also is a measure of the costs of forest recreation to the individual in comparison with the costs of other forms of recreation. Evaluation of pleasure and inspiration of the forest visitor, his primary objectives in visiting the forest, is something for the future. Certain studies have already been made on esthetic measurement, and it is reasonable to expect that, with the rapid progress being made in the methods of psychology and sociology, adequate evaluation of these intangibles may some day be achieved.

FOREST MANAGEMENT

RS - INT
SILVICULTURE
Harvest Cuttings

March 15, 1940

HARVEST CUTTINGS (PONDEROSA PINE)

1. Field division: Forest management research.

2. Work project: Silviculture.

3. Line project: Harvest cuttings.

4. Purpose: To determine the best methods of cutting ponderosa pine from the standpoints of reserve stand growth, natural regeneration, sustained yield, and watershed protection.

5. Review of past work: The principal line of work has been the measurement of actual results of various methods of cutting on permanent sample plots established for this purpose. Information on growth, mortality, reproduction, and logging damage has been derived and reported for a total of 23 plots on the Payette, Boise, and Salmon National Forests, some of them dating back to 1913. Similar data on an extensive scale were provided by a survey of five selectively cut areas in central Idaho. Experimental cuttings were made on the Boise Basin Experimental Forest in 1933. None have been made since. It is planned to further develop this experimental forest as a testing and demonstration area. Five periodic surveys (1935-39) of the experimental forest have been made to determine mortality from barkbeetle attack - a question of major importance in this type.

6. Accomplishments during past year: The barkbeetle survey of 1939 indicated a loss of 70 trees or 103,072 bd.ft. of ponderosa pine on 2,182 acres of virgin pine type, equivalent to 0.4 percent of the total volume of the stand. The annual loss has decreased progressively through the five years of record. Barkbeetle loss of Douglas fir is also on the decrease.

7. Plans for next year: (1) Compile remeasurement data, particularly on reproduction phases. (2) Check transects. (3) Complete report on extensive cut-over area study. (4) Annual barkbeetle survey. (5) Complete working plans for experimental forest.

8. Date of completion: Indefinite.

9. Assignment: T. E. Maki and E. L. Mowat.

RS - INT
SILVICULTURE
Stand Improvement

March 15, 1940

STAND IMPROVEMENT (PONDEROSA PINE)

1. Field division: Forest management research.

2. Work project: Silviculture.

3. Line project: Stand improvement.

4. Purpose: To evolve and test methods of stand improvement which are silviculturally and economically feasible in the ponderosa pine type.

5. Review of past work: (1) In 1934, 25 plots representing 5 degrees of thinning were established in sapling and pole stands. To date these have indicated that snow damage in the first 2 winters following treatment is heavy but not serious. (2) Demonstration areas established in 30-60-year-old stands have indicated that crop tree thinnings will yield up to 11 cords of fuel wood per acre, leaving a residual stand of over 100 trees including 40 to 50 choice well-spaced crop trees. (3) Pruning studies to date have indicated the type of tool suitable to use and the type of tree economical to prune. (4) Yearly removal of dead and dying trees on the experimental forest has supplied the village of Idaho City with a substantial portion of its fuelwood needs, and has served also as a sanitation and fire hazard reduction measure.

6. Accomplishments during past year: (1) Sanitation and hazard reduction cuttings continued on experimental forest. (2) Complete remeasurement of the 25 Bannock Creek sapling- and pole-stand thinning plots.

7. Plans for next year: Completion of analyses on past studies. Report preparation.

8. Date of completion: Indefinite.

9. Assignment: E. L. Mowat and _____.

March 15, 1940

SILVICS (PONDEROSA PINE)

1. Field division: Forest management research.

2. Work project: Silviculture.

3. Line project: Silvics (ponderosa pine).

4. Purpose: A major and a minor study are included. The major regeneration study aims to determine factors and conditions affecting natural reproduction through all stages, involving; (1) seed supply and distribution, (2) physical and biotic factors pertaining to germination and seedling establishment, and (3) factors pertaining to subsequent survival and growth. The minor forest phenology study aims to determine time of seasonal growth and other phenological events, to relate these to climatic data, and to use this information in other investigations and in forest management.

5. Review of past work: Regeneration factors: Cone crop records of 1,500 trees on permanent sample plots for past 6 years and seed trap studies have given useful data on seed production and distribution, showing adequate base supply in good seed years. During 1936-39 factors affecting germination, establishment, and growth were measured on a series of seeded plots in exclosures on north, south, and flat sites. Extensive transect studies (in addition to those on Mc plots) in 1935 and 1937 showed relations of soil, aspect, cover, etc. to establishment and first-year mortality of natural seedlings. Study in 1938-39 showed plant competition has little effect on germination, but greatly increases mortality and reduces size and vigor of seedlings.

   Phenology: On the Boise Basin Experimental Forest weekly measurements of current height and diameter growth of local tree species have been made through growing seasons of 1936-39; phenological notes and growth measurements have been made on key species of grasses, herbs, and shrubs.

6. Accomplishments during past year: Regeneration: Work on all of above phases continued; exclosure study completed except for analysis. Seed crop of 1939 light. Important detrimental effect of competition on seedlings further demonstrated; may show need of seedbed preparation to obtain reproduction on some cutting areas. Phenology: Observations continued on reduced scale; largely confined to tree measurements.

7. Plans for next year: Regeneration: Seed supply measurements to be continued. Competition study to be continued with additional seedings to determine seasonal differences. Compilation and analysis of all data to be brought up to date. Phenology: Data to be analyzed and correlated with weather records and results of interest reported; observations to be continued as for 1939.

8. Date of completion: Regeneration factors: mostly by 1942, with minor phases on to 1944 or beyond. Phenology: indefinite.

9. Assignment: E. L. Mowat.

RS - INT
REGENERATION

March 15, 1940

FIELD PLANTING AND SEEDING (PONDEROSA PINE)

1. Field division: Forest management research.

2. Work project: Regeneration.

3. Line project: Planting.

4. Purpose: To determine (1) the factors of site and of source, size, age and treatment of stock, and (2) the methods of planting and seeding responsible for good and poor survival and growth in order to develop (a) planting and seeding techniques, and (b) criteria of site selection which will insure successful regeneration of burned-over and otherwise denuded timber lands in the Intermountain region.

5. Review of past work: (1) Exploratory studies in planting and seeding since 1934 have indicated the problems of gross stock, site, technique, and biology that need solution to assure satisfactory regeneration. Use of husky stock having good balance between top and root volume, with care in site preparation, including reduction in competition, have shown to advantage in planting; artificial protection of seeds and reduction of competition have proved distinctly beneficial in seeding. (2) Experimental nursery studies have indicated desirable seedbed protection, water schedule, and thinning practices. (3) Studies of root systems of planted and natural seedlings have pointed the need for a better understanding of root physiology in relation to pruning, lifting, and planting practices. (4) Seed studies have furnished a reliable seed maturity index, and indicated desirable collection and storage practices.

6. Accomplishments during past year: (1) A source of stock, type of tool test, and a grade of stock-date of planting test were initiated. (2) Studies of seeding and planting comparisons were continued. (3) Phases of seed testing and storage were worked out.

7. Plans for next year: (1) Complete spring plantings and seedings in spring-fall tests. Examine new test plots as per schedule. Prepare reports on past seed and planting studies.

8. Date of completion: Indefinite.

9. Assignment: E. L. Mowat and _____.

RANGE MANAGEMENT

UTILIZATION STANDARDS FOR RANGE FORAGE PLANTS

1. Field division: Range research.

2. Work project: Grazing management.

3. Line project: Utilization standards: Determination of standards of satisfactory forage utilization on western ranges.

4. Purpose: This work, limited primarily to summer range types, is to determine (1) the proper degree of utilization for range forage plants, (2) suitable standards for judging the degree of utilization, and (3) the proper intensities of use for the various vegetational types.

5. Review of past work: Early work by Sampson (USDA Bull. 1405) and others led to the general conclusion that if 10 to 25 percent of the herbage of the more palatable species was left at the close of the grazing season proper utilization had been attained. In line with the above objectives this project was started at the Great Basin Branch Station in 1938. It cooperated with the Region in preparing a tentative handbook of utilization standards and made exploratory studies of the method of estimating utilization by stubble-height measurement, and the effect of different degrees of grazing individual plants upon their growth the subsequent year.

6. Accomplishments during past year: Six forests of the Region were personally visited by Clark and as a result of those field contacts and written comments from the forests the Utilization Handbook was completely revised and rewritten. Results obtained as to the effects of grazing on subsequent growth were checked with relation to yield, and the study of height-volume removal of forage plants was continued. Partly on the basis of these exploratory studies a comprehensive line project analysis, with a detailed breakdown by study phases, is being prepared.

7. Plans for next year: The Utilization Handbook is being considered for possible publication. Field studies will aim to determine: (1) proper-use factors and key species, (2) effect of use on subsequent forage yield, (3) suitable methods for (a) estimating utilization, (b) simulating grazing in controlled experiments, and (c) obtaining forage inventories. It would also be desirable to graze a series of small pastures (4 to 10 acres) to given degrees of utilization in order to determine just what intensity of use particular forage types can withstand.

8. Date of completion: Indefinite.

9. Assignment: Ira Clark.

March 15, 1940

SUCCESSIONAL STATUS OF VEGETATIONAL TYPES

1. Field division: Range research.

2. Work project: Grazing management.

3. Line project: Summer ranges: Methods of managing high summer ranges in the mountainous regions of the West.

4. Purpose: To determine the relation of the structure of plant communities now occupying extensive range areas to their potential structure under other systems of grazing management, and the rate of successional change.

5. Review of past work: Results of early work on plant succession on the Wasatch Plateau have been reported in USDA Bulls. 791 (1919) and 1405 (1926). Studies on seed germination have been reported in Bot. Gaz. 98:243-269, 1936, and a report has been submitted for publication covering other phases of seeding habits of native range plants. A progress report has been prepared on seedling survival, rating the principal forage species with regard to longevity and demonstrating slowness of recovery, even under protection, of greatly depleted range lacking a natural seed source.

6. Accomplishments during past year: Analysis of major-plot and permanent-estimate-plot records has so far yielded inconclusive results. With the help of State WPA labor uniform overlays have been prepared for current-series quadrat charts, which will facilitate study. A number of abandoned quadrat records made between 1913 and 1923 have been found in the Station and R.O. files. It has been possible to identify some of the old quadrats in the field, several of which indicate advancement in successional status. A few of the "abandoned" quadrats have been continued in the current series apparently in ignorance of their earlier history.

7. Plans for next year: To complete analysis and prepare report on current quadrat, major plot and permanent estimate plot records. To chart all rediscovered quadrats and analyze and interpret them with the help of the management records of the Manti National Forest. No new work of major character will be undertaken until analysis of past work is complete enough to permit efficient planning. Plans for building up the Great Basin Station herbarium, which were interrupted by the Range Seminar in 1939, will be followed out in 1940.

8. Date of completion: Indefinite.

9. Assignment: George Stewart and Lincoln Ellison.

RR - INT
MANAGEMENT
Summer Ranges

March 15, 1940

CLIMATE, PLANT GROWTH AND FORAGE PRODUCTION

1. Field division: Range research.

2. Work project: Grazing management.

3. Line project: Summer ranges: Methods of managing high summer ranges in the mountainous regions of the West.

4. Purpose: To determine relative influence of the various climatic factors on the rate of plant growth and amount of forage produced, the extent of variations in forage production which may be expected to occur, and adjustments of range management which may be necessary to conform with such variations.

5. Review of past work: Results of short-term studies prior to 1923 were published as USDA Bull. 1405. A climatic summary for four stations on the west front of the Wasatch Plateau for the 20-year period, 1914-34, was published in the Monthly Weather Review 65:291-301, 1937. Technical Bulletin 686 "Weather and Plant Development Data as Determinants of Grazing Periods on Mountain Range" was published during 1939. This bulletin summarizes the relationships between climate, as altered by altitude, and the phenology of some range forage species on the west front of the Wasatch Plateau. Evidence is given of a relationship between snow melt in spring and subsequent phenological development which permits more accurate prediction of range readiness than does an arbitrary average date.

6. Accomplishments during past year: The technique of making phenological observations was revised, with the purpose of obtaining greater objectivity, and was used in this modified form during 1939. A test has been begun, using the data for 1936-39, to compare the value of predictions of range readiness based on the average and on date of snow melt, as described in Tech. Bull. 686.

7. Plans for next year: Plant development observations will be continued and correlation plots will be harvested. Conclusions in Tech. Bull. 686 will be tested using plant-development records subsequent to 1935. A study will be made of the problem of devising a more satisfactory means of determining forage yield than the present correlation plots provide.

8. Date of completion: Indefinite.

9. Assignment: Lincoln Ellison.

RR - INT
MANAGEMENT
Summer ranges

March 15, 1940

PHYSIOLOGICAL STUDIES OF RANGE PLANTS

1. Field division: Range research.

2. Work project: Grazing management.

3. Line project: Summer ranges: Methods of managing high summer ranges in the mountainous regions of the West.

4. Purpose: To determine the effects on the physiological activities of the plant caused by clipping and grazing at various seasons and intensities.

5. Review of past work: In cooperation with the late Dr. E. C. McCarty of Riverside Junior College, studies were begun in 1932, and field work completed in 1936. One report was published as USDA Tech. Bull. 598 in 1938 describing the physiological process of carbohydrate storage on range plants and its relation to subsequent vigor and growth.

6. Accomplishments during past year: A manuscript, "Growth and carbohydrate food ratios of important range forage plants and their reactions to clipping and grazing treatments" is now in hands of the editor. Carbohydrate reserves are depleted by removal of foliage closely and frequently. They are impaired only slightly by moderate grazing after seed maturity.

   A second manuscript, "The effects of fall clipping intensities on yield and vigor of two important western browse plants", now in preparation describes the effects of fall clipping upon the yield and vigor of Cercocarpus and Symphoricarpos. Removal of current growth which leaves 1 inch or more does not seem to harm the plants but to stimulate growth.

7. Plans for next year: Clipping studies will be incorporated into the Utilization Standards project. Until further funds become available the chemical attack will be discontinued.

8. Date of completion: Completed under this project.

9. Assignment: Raymond Price to see carbohydrate and browse manuscripts through publication.

RR - INT
MANAGEMENT
Summer Ranges
Idaho

March 15, 1940

SUCCESSIONAL STATUS OF BUNCHGRASS-GRANITIC SOIL RANGE VEGETATIONAL TYPES

1. Field division: Range research.

2. Work project: Grazing management.

3. Line project: Summer ranges: Methods of managing high summer ranges in the mountainous regions of the West.

4. Purpose: To determine for bunch wheatgrass (Agropyron inerme and A. spicatum) on granitic soils (1) the vegetational condition of the plant communities now occupying extensive range areas and their potential condition under protection or modified grazing management, and (2) the rapidity with which changes take place.

5. Review of past work: Range inspections during the period 1929-1931 indicated that overgrazing is largely responsible for the serious erosion problem which exists on the Boise River watershed. A system of 100 meter quadrats and 105 major plots was established in connection with 11 enclosures, to study the natural vegetation of the watershed. Analyses of early records from these plots indicate that (1) natural plant cover, when not weakened by excessive grazing, provides adequate erosion control; (2) on much of the area proper grazing will permit recovery and maintenance of natural plant cover; but (3) on seriously depleted foothill ranges natural revegetation of suitable species is prevented because of lack of seed source, so that artificial revegetation will be necessary. Inspection of the data collected during the first 9 years of the study seems to show that there has been considerable fluctuation in density from year to year but that the general trend is downward, owing to the abnormally low precipitation which has prevailed.

6. Accomplishments during past year: Preliminary examination of the plot data for the years 1931 and 1937, the first and last years in which all of the plots were measured, seems to indicate that protection from grazing is having a beneficial influence upon the vegetation. When the total densities of perennial grasses in protected plots is compared with the densities of the grazed plots paired with them, it was found that the protected plots have about maintained themselves but that the grazed plots have deteriorated more than 40 percent. Variance analysis shows that the density of vegetation on the grazed plots is significantly lower than that of the protected ones.

7. Plans for next year: All plots, or at least all paired plots, will be remeasured, an analysis will be made comparing 1940 data with those of 1931, and if the results of the analysis warrant it, a short paper will be prepared to show the results of the first 10 years of the study.

8. Date of completion: Indefinite.

9. Assignment: George Stewart and C. Allan Friedrich.

RR - INT
MANAGEMENT
Spring-Fall

March 15, 1940

ECOLOGY OF THE SAGEBRUSH-GRASS SPRING-FALL RANGES

1. Field division: Range research.

2. Work project: Grazing management.

3. Line project: Spring-fall ranges: Methods of managing foothill spring-fall ranges in the mountainous regions of the West.

4. Purpose: To determine for the sagebrush-grass spring-fall ranges the relation between environment and plant growth, with special attention to the relative importance of the various climatic factors on and the extent to which they influence plant growth and herbage production; the structure of the plant community and the rapidity with which changes take place; and the relation of the present community to grazing use.

5. Review of past work: Vicissitudes of climate as it affects the rate and character of plant growth is one of the most important factors in the management of native ranges. Similar stages of plant development from one year to another may vary 40 days in the time of their occurrence. Flower stalk production is very uncertain and the production of viable seed relatively infrequent. Major forage species make additional growth during the period July 1 to October 1 only about once every 5 years.

   Severe droughts result in more or less protracted damage to the stands of perennial grasses -- damage that is not overcome in a 5-year period of favorable conditions following the drought.

   Forage production, as indicated by density, may vary from 60 percent above to 65 percent below the average with two or more deficient years occurring successively. Recovery of seriously depleted spring-fall sagebrush-grass range areas is extremely slow, attributable to almost complete dominance of big sagebrush, Artemisia tridentata, following depletion.

6. Accomplishments during past year: For the second consecutive year since the drought Agropyron spicatum has shown a significant increase in basal area over the previous year, but it still remains 30 percent below its 1932-1933 level.

Balsamroot has been found to be a highly nutritive forage, equal to good alfalfa hay during the first 30 to 40 days of its growth, but decreasing rapidly in value with maturity until in the fall it is but a poor roughage, with a very low calcium/phosphorus ratio.

7. Plans for next year: This subproject will be continued under present plans during 1940.

8. Date of completion: Indefinite.

9. Assignment: Joseph F. Pechanec and George Stewart.

RR - INT
MANAGEMENT
Spring-Fall

March 15, 1940

METHODS OF HANDLING SAGEBRUSH-GRASS SPRING-FALL RANGES UNDER GRAZING USE

1. Field division: Range research.

2. Work project: Grazing management.

3. Line project: Spring-fall ranges: Methods of managing foothill spring-fall ranges in the mountainous regions of the West.

4. Purpose: To determine for sagebrush-grass spring-fall ranges the effect of different methods of grazing management, and different seasons and intensities of grazing upon individual plant species and upon sustained animal and forage production.

5. Review of past work: Investigations begun in 1923 indicate that continuous fall grazing, with key grass species receiving about 60 percent utilization, is not detrimental; spring grazing practiced continuously under the approximate intensity commonly used on adjacent open ranges continued for a 15-year period, results in the almost complete extermination of valuable forage species and the serious encroachment of big sagebrush; fairly heavy grazing consistently during any single part of the spring grazing period is detrimental to the maintenance of forage productivity; to obtain fullest sustained use of these ranges rotation of grazing seems necessary.

   During the drought of 1934, rotation and rotation-deferred grazing systems seemed superior to continuous grazing. From the standpoint of forage maintenance the rotation-deferred system appeared slightly superior to the rotation system.

   Proper use of Agropyron spicatum appears to be 30 percent of the current herbage growth in the spring and a total of 60 percent by the end of the fall season.

   Removal of sagebrush on areas with a good grass understory permits the fullest benefits to accrue from management systems. Increases in forage production of 150 percent in two years resulted from removal of sagebrush by fire followed by proper grazing management.

6. Accomplishments during past year: During 1939 the palatability of Agropyron spicatum was so low that had it been used to 30 percent of its current growth associated species would have been seriously damaged.

7. Plans for next year: Study will be continued as planned during 1940.

8. Date of completion: Present phase - 1940. With modification needs to be continued at least 8 more years.

9. Assignment: George Stewart and Joseph F. Pechanec.

RR - INT
MANAGEMENT
Spring-Fall

March 15, 1940

METHODS OF STUDYING SAGEBRUSH-GRASS SPRING-FALL RANGE VEGETATION

1. Field division: Range research.

2. Work project: Grazing management.

3. Line project: Spring-fall ranges: Methods of managing foothill spring-fall ranges in the mountainous regions of the West.

4. Purpose: To determine the most efficient methods of measuring native sagebrush-grass range vegetation and to investigate the nature of variation in experimental material being used, methods of sampling, and types of experimental design that may increase the efficiency of range experimentation.

5. Review of past work: Testing adaptability of methods of studying native range vegetation was actively begun in 1932. The point-observation-plot method of determining plant density and the coordinate method of mapping shrubs were tested and found suitable; a study of five different methods of determining percentage utilization indicated that the ocular-estimate-by-plot methods used in conjunction with actual checking of estimates provide fairly reliable estimates; and the weight estimate method was designed, tested, and found superior to estimates of density.

   Covariance analysis, as a means of improving the efficiency of range experiments, seems to have very promising possibilities.

   Range research is faced with variations in experimental material three to seven times as great as that found in agricultural experiments and, when the present types of sampling units are used, strongly skewed distributions result. Personal error in rapid estimate methods is far less serious than the lesser intensity of sampling that accompanies the more tedious clipping methods.

   Sampling to an intensity two to three times as great as now employed, smaller pastures or experimental units and more efficient design seem to be definitely necessary to insure more successful experimentation.

6. Accomplishments during past year: For a single section of sagebrush-grass range, using the weight estimate method, and 20 plots per section, the sampling error of the estimated forage yield was found to be 18 percent. Individual plant species determinations had a higher sampling error. Using 20 plots to the section, forage yield on blocks of 4 sections would have a sampling error of 10 percent, provided that the sampling was properly randomized within sections.

7. Plans for next year: More attention is to be given to personal error of estimates and means of reducing it.

8. Date of completion: Indefinite.

9. Assignment: Joseph F. Pechanec.

RR - INT
MANAGEMENT
Winter Ranges

March 15, 1940

SUCCESSIONAL STUDIES IN RANGE PLANT TYPES

1. Field division: Range research.

2. Work project: Management winter ranges.

3. Line project: Successional studies in range plant types.

4. Purpose: To determine (1) general condition of winter ranges in respect to plant cover; (2) the degree and rapidity of recovery and natural revegetation on properly managed and totally protected ranges; (3) the role of establishment and increase in vigor of the better forage plants; (4) the management methods best adapted to meet the requirements for production of plants and yet serve the livestock to the greatest possible degree.

5. Review of past work: General surveys of the winter ranges in western Utah and Nevada indicated that the plant cover had been reduced 34 percent from pristine conditions and forage volume had decreased 62 percent as a result of heavy grazing and improper seasonal use. Forage volume more than doubled on typical winter ranges in western Utah subjected to proper use for a period of 5 years. Areas totally protected from grazing for 2 to 5 years show a marked increase in plant vigor, plant cover, and soil stabilization. Forage production on these areas is now from 1.5 to 2.5 times greater than on the adjacent open range. Indian ricegrass (Oryzopsis hymenoides) produces 3 to 6 times more forage per plant on the protected enclosure than on the open range. In protected enclosures and on properly utilized range units Russian-thistle (Salsola pestifer), rabbitbrush (Chrysothamnus stenophylus) and other inferior forage plants abundant on the open range have almost disappeared. Seedling production and survival of the better forage plants is 2 to 4 times greater on the enclosed areas. On properly utilized ranges 20 to 25 percent of the better forage plants should be left and only 50 to 55 percent of the current herbage should be taken.

On four enclosures fenced in 1932 ricegrass had by 1938 increased 2.0 to 5.5 times, galleta grass (Hilaria jamesii) 2.7 times, and winterfat (Eurotia lanata) 1.8 times. Shadscale (Atriplex confertifolia) about held its own but rabbitbrush, an inferior forage that had increased 1.5 times on the open range, had decreased 33 percent in the enclosures.

6. Accomplishments during past year: Two additional enclosures studied during 1939 showed, at Ely, Nevada, an increase of almost 46 percent since 1937 in winterfat, which constituted about 75 percent of the vegetation. At Wellington, Nevada, another enclosure showed a gain in the two years of 37 percent in black sage (Artemisia nova) which constituted more than 90 percent of the forage.

7. Plans for next year: Additional enclosures established since 1932 will be estimated and data analyzed.

8. Date of completion: Indefinite.

9. Assignment: Selar S. Hutchings and George Stewart.

RR - INT
MANAGEMENT
Winter Ranges

March 15, 1940

ECOLOGICAL FACTORS AFFECTING RANGE FORAGE PLANTS

1. Field division: Range research.

2. Work project: Management winter ranges.

3. Line project: Ecological factors affecting range forage plants.

4. Purpose: To determine (1) relative influence of various climatic and soil factors on forage production; (2) effect of climatic fluctuations on plant growth; and (3) adjustments in range management necessary to compensate for variability in forage yield.

5. Review of past work: Climate at the Desert Range Branch is extremely variable. Precipitation is erratic and varies greatly from season to season and from month to month. In 1933 (June to October) rainfall was only 0.33 inch, whereas for the same period in 1935 it was 4.00 inches. Summer storms are frequently localized and often occur as torrential downpours, causing rapid run-off. Winter snowfall is also variable. Frequently one locality will receive from 5 to 10 inches of snow, when part of the same valley and adjacent valleys will be suffering from a lack of precipitation. Forage growth varies as much as 300 percent between dry and wet seasons and as much as 250 percent on localized areas during a single season. Since use of the major portion of the winter ranges of the Intermountain region is dependent on snowfall, range management must be flexible enough to meet the variations in forage production that arise from vicissitudes of climate. During 1938 precipitation was 9.68 inches, or 26 percent above the average since 1933 when the station was established. Heavy winter precipitation and timely spring and early summer rains produced a plant growth 25 to 35 percent greater than that of 1937.

6. Accomplishments during past year: The year 1939 was dry, precipitation being only 5.11 inches. Since January, February, and March were unusually dry, growth of vegetation was only about half as great as that of 1937 and about a third of that of 1938. When winter grazing began in November the supply of available forage was low.

7. Plans for next year: Study will be continued and 5-year plant growth and weather data will be compiled and analyzed.

8. Date of completion: Indefinite.

9. Assignment: Selar S. Hutchings.

RR - INT
MANAGEMENT
Winter Ranges

March 15, 1940

UTILIZATION, SEASONAL USE, AND ANIMAL RESPONSE

1. Field division: Range research.

2. Work project: Management winter ranges.

3. Line project: Utilization, season, and intensity of grazing.

4. Purpose: To determine (1) degree of utilization that will insure rehabilitation of desert ranges and insure their maintenance in perpetuity; (2) relative influence of intensity and season of use on plant cover and forage production; and (3) influence of degree of utilization on condition of sheep as reflected in the weight of animals and the volume of animal products.

5. Review of past work: Eighteen 320-acre pastures stocked since 1936-37 indicate the proper intensity of grazing at the experimental range to be approximately 0.04 forage-acre a head per month which requires approximately $2\frac{1}{2}$ acres a head per month. Improvement of the plant cover under proper stocking indicates that the rate of stocking can now be increased from one-fourth to one-third. Plant vigor and herbage yields have increased fully twice as much as has the plant density.

During a 40-day winter pasture study the average change in weight of sheep under heavy, moderate, and light use during 1937-38 was -3.45, +3.76, and +5.98 pounds, respectively. On properly grazed herd allotments on the experimental range, ewes gained 4.57 pounds in 42 days and lambs 2.88 pounds. Two flocks of sheep alternate yearly between the moderately grazed experimental area and the heavily grazed open range. The herd on the experimental range produced 0.83 pound more wool per animal, a 4 percent greater lamb crop, and wintered in better flesh without the aid of supplemental feed than those grazed on the open range, which were fed during the winter $400 worth of cottonseed cake.

The net profit on the herd wintered on the experimental range under properly managed range was 58 cents per head greater than for the herd wintered under outside conditions. In 1938 the wool clip of the sheep in the experimental area averaged a third of a pound heavier than on the outside range, and had a 7 percent heavier lamb crop.

6. Accomplishments during past year: Sheep grazed on pastures during 1938-39 in the fall showed changes in flesh weight of -3.20, +0.61 and +4.30; those grazed during winter -4.15, -1.75, and +3.05; and those grazed in spring +1.84, +7.26, and +6.63 pounds per ewe for heavy, moderate, and winter grazing respectively. The average wool weight per ewe on the properly managed experimental range was more than 1.0 pound greater than those on adjacent open range.

7. Plans for next year: Continue studies on influence of degree of use on condition of sheep and range forage production.

8. Date of completion: Indefinite.

9. Assignment: George Stewart and Selar S. Hutchings.

RR - INT
ARTIFICIAL REVEGETATION
Species Adaptability

March 15, 1940

SUITABILITY OF PLANT SPECIES FOR ARTIFICIAL REVEGETATION

1. Field division: Range research.

2. Work project: Artificial revegetation.

3. Line project: Suitability of plant species for artificial revegetation.

4. Purpose: To determine which forage species, whether native, introduced or produced by plant breeding, are best adapted to the various problem areas of the Intermountain region.

5. Review of past work: In last year's report a number of species were mentioned as having shown promise in recent experiments for the reseeding of certain problem areas as indicated below:

   1. Depleted sage areas: Arrhenatherum elatius, Bouteloua gracilis, Hilaria jamesii, Lupinus ornatus, Oryzopsis hymenoides, Poa bulbosa, Robinia pseudoacacia, Rosa fendleri, and Stipa arida.

   2. Burned sage areas: (Same as depleted sage).

   3. Abandoned cultivated lands: Agropyron cristatum, A. smithii, Elymus glaucus, Oryzopsis hymenoides, Poa ampla, and P. nevadensis.

   4. Mountain brush areas: Agropyron pauciflorum, Elymus canadensis, E. glaucus, Lespedeza stipulacea, and Poa ampla.

   5. Depleted aspen type: Bromus carinatus and B. inermis.

   6. Depleted subalpine type: (Same as depleted aspen).

6. Accomplishments during past year: Further work has shown that the following species as listed in last year's report have proved unsuited to the sites previously indicated: Hilaria jamesii and Lespedeza stipulacea.

   During the past year 249 species have been seeded on 3,398 plots. On the basis of data gathered additional species appear to be adapted to the following problem areas:

1. Depleted sage areas: Agropyron spicatum, Caragana arborescens, Elaeagnus augustifolia, and Poa secunda.

2. Burned sage areas (same as preceding area).

3. Abandoned cultivated lands: Agropyron inerme, A. spicatum, Arrhenatherum elatius, Elymus condensatus, E. triticoides, and Stipa viridula.

4. Mountain brush areas: Agropyron cristatum, A. subsecundum, Arrhenatherum elatius, Bromus inermis, Elymus condensatus, E. triticoides, Hordeum bulbosum, Stipa columbiana nelsoni, and S. viridula.

5. Depleted aspen type: Agropyron pauciflorum, A. subsecundum, Arrhenatherum elatius, Stipa columbiana nelsoni.

6. Depleted subalpine type (same as depleted aspen).

While the above mentioned species show promise on the areas indicated, further tests will probably show an extension of their usefulness to other ecological sites. The search for legumes is progressing satisfactorily and 30 new species have been tested, of which the following are most noteworthy: Astragalus rubyii, Glycyrrhiza lepidota, Lotus spp., Lupinus alpestris, and Trifolium spp.

USDA Farmers' Bulletin 1823 which redefines the possibilities of reseeding and presents the existing status of knowledge was published during the past year.

The species adaptability problem has been carefully analyzed and it is evident that this problem should first be studied on small plots where plant competition is controlled. Species which these first tests prove to be adapted to particular soil and site conditions will be tested on larger plots under actual range conditions. Range plot tests will yield information which may be applied to large-scale plantings. As a result of this analysis and a strict adherence to the policy of writing detailed study plans the species adaptability studies are on a substantial basis.

The weight estimate method developed by Pechanec and Pickford has been modified, tested, and found to be admirably adapted for measuring forage yield of reseeded plots.

7. Plans for next year: Observations on older plantings will be continued to determine species adaptability. As new species are made available through collection, purchase, exchange, or plant breeding they will be added to the species trials and those showing promise in these trials will be tested on range plots and finally on large-scale plantings.

To determine species adaptability more adequately a study of the distribution of important native forage species to determine possible extension of their range is being initiated.

8. Date of completion: This project will be continued indefinitely to test newly acquired and developed species and strains.

9. Assignment: George Stewart, C. Kenneth Pearse, A. C. Hull, Jr., Perry Plummer, Richard Hurd, and Joseph Robertson.

RR - INT
ARTIFICIAL REVEGETATION
Site Factors

March 15, 1940

SITE FACTORS: SOILS, CLIMATE, ALTITUDE, AND OTHER FACTORS AFFECTING ARTIFICIAL REVEGETATION

1. Field division: Range research.

2. Work project: Artificial revegetation.

3. Line project: Site factors: Soils, climate, altitude, and other factors in relation to growth requirements of species used in artificial revegetation.

4. Purpose: To determine the effect of site factors on the growth and ultimate forage production of species used in artificial revegetation.

5. Review of past work: Variations in mineral nutrient content, organic matter, and water relations of soils strongly influence results of revegetation work. Recent experiments have shown that competition with native vegetation was responsible for many cases of poor establishment of reseeded species. Past work has shown that seeds of many native forage species have peculiar germinative characteristics.

6. Accomplishments during past year: Poa bulbosa has continued to show its aggressiveness and ability to replace cheatgrass on a number of competition plots sown in 1937.

The suppressive effect of sagebrush on the establishment of perennial grasses was indicated on 10 pairs of burned and unburned plots at Clover Creek. Seeding to 4 species was done in the fall of 1937, following burning of one plot of each pair in August. Measurements made in the summer of 1939 showed that the individual plants on the burned plots weighed an average of 13.7 grams against an average of only 1.9 grams for plants on unburned series. Because not only the size, but also the numbers of plants was affected by burning, the total green herbage produced was 18 times greater on the burned than on the unburned plots.

Recent field tests with Oryzopsis hymenoides have shown that germination under field conditions will occur if seeds are allowed to lie in the soil for 1 year or more.

7. Plans for next year: Germination studies of species with refractory seeds will be continued. The possibility of increasing available nitrogen in soils through the use of legumes will be investigated in greenhouses and field tests. Studies of the cause of suppression of grasses by sagebrush will be initiated in order to provide basic data necessary for the intelligent reseeding of sagebrush areas.

8. Date of completion: Indefinite.

9. Assignment: A. C. Hull, Jr., C. Kenneth Pearse, George Stewart, Joseph Robertson, Perry Plummer, Richard Hurd.

March 15, 1940

METHODS: TIME, DEPTH, CULTURE, PRACTICABILITY, AND COST OF PLANTING

1. Field division: Range research.

2. Work project: Artificial revegetation.

3. Line project: Methods: Time, depth, culture, practicability, and cost of planting.

4. Purpose: To determine the most practical time and methods of planting and subsequent treatment in the revegetation of depleted ranges.

5. Review of past work: Drilling, harrowing, plowing furrows, followed by brush dragging and in some cases trampling with sheep have been shown to be satisfactory methods of seeding dry ranges of the Intermountain region. Drilling has proved to be the most effective method and special drills for seeding steep slopes have been developed. Fall has been shown to be the most desirable season for planting. Satisfactory stands have been obtained with most species when seeding was at the rate of 4 to 8 pounds per acre. Seed should be planted just deep enough to insure a continuous moisture supply after germination. This varies from 1/4 to 2 inches depending on species and soil.

6. Accomplishments during past year: Continued work has shown 1-horse drills to be adapted to a great variety of planting conditions. Additional modifications of the 1-horse side-hill drill, to permit three disks always to throw downhill and thus leave the seed planted at the bottom of miniature contour furrows, has made drilling on steep slopes more effective.

   By more effective planting, such as obtained through drilling or other methods of uniformly covering seed, the rate of seed per acre necessary to produce a good stand on dry sites has been cut to as low as 3 pounds per acre for crested wheatgrass and 4 or 5 pounds per acre for most other common species.

   To obtain basic information necessary for large-scale planting, detailed field work on date and depth of seeding for several species over a 4-year period has been commenced at Mantua, Arrowrock, Burch Creek, Lime Canyon, and Paradise Valley. The first results show that season of planting greatly affects the optimum depth.

One comprehensive study involving the practical testing of 7 methods of planting on duplicate 3/4-acre plots and 4 less extensive studies of methods of planting all of which should yield directly applicable results have been initiated. Two studies of the effectiveness of nurse crops have been begun.

Gratifying progress has been made in the attempt to adapt the hormone treatment for inducing rooting of native shrub cuttings. Comparatively high concentrations of indole$_3$ acetic acid (200 mg./liter) increased the rooting of Rosa fendleriana and Rhus trilobata so significantly in the greenhouse that field studies on road cuts and gully banks are indicated.

7. Plans for next year: Difficulties of planting, coupled with plant competition, continue to hinder the establishment of planted species in sagebrush and mountain brush. Methods of treating both sagebrush and mountain brush areas to insure successful establishment of reseeded species will be continued. Detailed studies of season, rate and depth of seeding, and row spacing of the principal species adapted for each site will be continued and emphasis will be placed upon applying the research results to large-scale plantings, including the development and testing of special machinery.

8. Date of completion: Indefinite.

9. Assignment: C. Kenneth Pearse, A. C. Hull, Jr., Perry Plummer, C. Allan Friedrich.

RR - INT
ARTIFICIAL REVEGETATION
Plant Breeding

March 15, 1940

PLANT BREEDING: SELECTION AND HYBRIDIZATION

1. Field division: Range research.

2. Work project: Artificial revegetation.

3. Line project: Plant breeding: Selection and hybridization (conducted in cooperation with the Bureau of Plant Industry and the Utah State Agricultural Experiment Station, the Bureau of Plant Industry acting as leader and prosecuting the detailed work).

4. Purpose: To produce improved strains of range plants by selection. To determine the pollen production and quality, and pollination and seeding habits of range plants as a basis for hybridization studies; and to produce improved strains of range plants by hybridization.

5. Review of past work: Several hundred individual plants of the more promising species for revegetation work have been studied and selections have been made on the basis of leafiness, seed production, erectness and rate of spread of rhizomes. Mass selection strains of Bromus inermis and Agropyron smithii planted at the dry land nurseries are becoming established. A supply of self-pollinated seed has been obtained by means of bagging in order to provide homozygous material with which to begin hybridization studies.

6. Accomplishments during past year: Four strains or selections of Agropyron cristatum, 12 of A. inerme, 5 of A. pauciflorum, 7 of A. smithii, 12 of A. spicatum, 5 of Bromus inermis, 2 of Poa ampla, and 5 of P. pratensis have been secured from various sources and planted at field nurseries.

   Selection and inbreeding have been continued to determine the pollination habits and responses of various species and to prepare the way for breeding by hybridization. Plants of Sitanion hystrix totalling 517 were gathered throughout central Utah to furnish material for selection and hybridization of this species.

7. Plans for next year: Work will be continued on very much the same basis as it has been during the past year. Hybridization will be attempted as soon as desirable pure, or nearly pure, strains are available.

8. Date of completion: Indefinite.

9. Assignment: Wesley Keller, Bureau of Plant Industry; advisory, George Stewart and C. Kenneth Pearse, Forest Service.

RE - INT
RANGE ECONOMICS

March 15, 1940

AREA STUDIES IN RANGE ECONOMICS

1. Field division: Range economics.

2. Work project: Range economics.

3. Line project: Elko county cooperative study.

4. Purpose: To make an economic analysis of the landuse adjustment problems of Nevada Grazing District No. 1 as a basis for public land administration policies.

5. Review of past work: The cooperative range survey and the compilation of the commensurate property records are nearing completion. The ranch economic survey records obtained in 1938 were analyzed during 1938 and 1939. These data have been put in graphic and statistical form for publication in a final report.

6. Accomplishments during past year: A recent meeting of the cooperating agencies agreed upon a definite plan for completion of a final report on this study during 1940.

7. Plans for next year: Preparation and publication of a final report.

8. Date of completion: 1940

9. Assignment: Mont H. Saunderson

AREA STUDIES IN RANGE ECONOMICS

1. Field division: Range economics.

2. Work project: Range economics.

3. Line project: Central Utah area economic study.

4. Purpose: To evaluate, for the Fishlake and the Manti National Forests and Utah Grazing Districts Nos. 3 and 7, the economic and social consequences of the different alternatives which may be followed by public land administration, in the conservation and the use of the public lands for the grazing of farm and ranch livestock.

5. Review of past work: This project was initiated in 1939.

6. Accomplishments during past year: A selected sample of farm and ranch organization and operating records was obtained, in cooperation with the Utah State Agricultural College, for approximately 10 percent of the 6,000 farm and ranch operating units of the area. An analysis was made, for all forest and grazing district permittees, of the type of public-land grazing use now made by different size classes of livestock enterprises. This analysis shows the use-interrelationship of summer and winter range, the length of trail movements, and the proportion of public-land range absorbed by the different size classes of livestock enterprises.

   Approximately one-third of the grazing by cattle on public lands of the area is attributable to small-farm cattle enterprises. These small-farm cattle enterprises afford some added labor income to the farm operators. A study of the farm operating records shows a low production for these small enterprises and there are indications that many of these could be operated more efficiently without the use of public-land grazing permits. This adjustment would require some reorganization of the farm enterprises and better use of farm land and irrigation water to produce more pasture and other farm feed.

7. Plans for next year: The farm and ranch contracts of the Agricultural Adjustment Administration will be analyzed to give the area picture of the organization of all operating units and the uses of all crop lands. This will show the relation of public land grazing use to the entire farm economy of the area.

8. Date of completion: June 1941.

9. Assignment: Mont H. Saunderson and Arthur Roth.

RE - INT
RANGE ECONOMICS March 15, 1940

REGIONAL STUDIES IN RANGE ECONOMICS

1. Field division: Range economics.

2. Work project: Range economics.

3. Line project: A graphic summary of grazing on the public lands of the Intermountain region.

4. Purpose: To provide a statistical and cartographic background of present public land utilization as a guide to forest and range research and administration, and to Federal-State extension work in agricultural policy and program formulation.

5. Review of past work: This project was initiated in 1939.

6. Accomplishments during past year: With the help of a WPA statistical project, an analysis was made of all of the forest grazing permits and commensurate property records for Region 4, and all of the grazing district permits for Region 4. These data have been put in graphic form to show the regional picture of economic relationships between different types of land resources, the range-management and conservation aspects of the individual forest and grazing-district grazing uses, and the present situation of grazing-use distribution to the different size classes of livestock operations.

7. Plans for next year: Publication in mimeographed form to be completed in 1940.

8. Date of completion: September 1940.

9. Assignment: Mont H. Saunderson and Arthur Roth.

INFLUENCES

RI - INT
STREAM FLOW
Woodland
Great Basin

March 15, 1940

STREAM FLOW (TREE, SHRUB, GRASS)

1. Field division: Forest and range influences.

2. Work project: Influence of natural vegetation on stream flow.

3. Line project: Woodland cover: Relation of woodland cover (tree, shrub, grass) to stream flow.

4. Purpose: To determine on watersheds and plots the management practices which will assure the greatest yield in quantity and quality of stream flow and maintain optimum soil conditions.

5. Review of past work: In the Great Basin about 80 percent of stream flow originates from melted snow on range lands above 7,000 feet elevation. In Utah 1¼ billion dollars is largely dependent on such stream flow. Spring run-off, when demand by users is low, amounts to 65 to 90 percent of the total annual flow, whereas July, August, and September flow, when demand is high, may not exceed 6 percent of the annual yield. Apparently south aspects differ from north aspects in quality of water yielded. Surveys indicate that quality of stream flow has been changed as a result of watershed utilization. In many instances destructive mud-rock flows have done much damage to valley property and potential floods continue to threaten the social and economic well-being of many communities.

   The Wasatch Stream Flow Laboratory has been established in northern Utah in the water yielding zone of the Wasatch Mountain front. The total area comprises about 4,800 acres of which 2,258 consists of 11 watersheds with permanent streams. Six of these north-facing watersheds with aspen-fir and woodland cover, comprising about 840 acres have been equipped with Venturi-trapezoidal water-measuring flumes. Necessary climatic apparatus has been installed and plant and soil inventories have been made.

6. Accomplishments during past year: Construction of 5 Venturi-trapezoidal flumes on 5 south-facing experimental watersheds, comprising about 1,400 acres in shrub and herbaceous types, and installation of contour trails, climatic and soil-moisture sampling stations will be completed by July 1, 1940. Silt tanks on 16 surface run-off plots have been doubled in size. Progress has been made on stream flow compilation using WPA funds.

7. Plans for next year: Operate all installations, make soil and plant inventory on 5 south-facing watersheds. Continue compilation and analysis.

8. Date of completion: Indefinite.

9. Assignment: A. R. Croft.

RI - INT
STREAM FLOW
Herbaceous cover
Great Basin

March 15, 1940

STREAM FLOW (HERBACEOUS VEGETATION)

1. Field division: Forest and range influences.

2. Work project: Influence of natural vegetation on stream flow.

3. Line project: Grassland: The role of grassland in influencing stream behavior.

4. Purpose: To determine on small watersheds and plots the management practices that will maintain plant cover conditions favorable for optimum surface run-off and prevention of accelerated soil erosion.

5. Review of past work: The effect of grasses and other herbaceous plant cover in controlling surface run-off and erosion was determined by studies on watersheds A and B on the Wasatch Plateau prior to 1929. Reversal of the management practice on these two watersheds since 1935 indicates that plant cover relationships are more important in controlling run-off and erosion on these areas than other differences that may exist between them, such as size, shape, slope, or gully pattern. Destructive floods and accelerated soil erosion throughout the region have been shown by observations to be correlated with reduced herbaceous plant cover and excessive disturbance of soil by grazing. As a basis for further study of the influence of this type of cover on erosion and run-off, six 1/10-acre plots have been established at the Great Basin Branch Station, and twenty-four 1/200-acre plots have been established on foothill lands in Davis County, Utah.

6. Accomplishments during past year: All installations have been operated. No summer run-off occurred in 1939 from A and B watersheds, therefore, A/B run-off and erosion ratios remain at 0.56 and 0.55, respectively, as reported in 1938. Conducted informal infiltration study on Ephraim Creek watershed soils.

7. Plans for next year: Operate all studies related to project. Install two yearlong soil moisture sampling pits at A/B watersheds. Make an informal study of snow melting, infiltration, and stream flow at Ephraim Creek watershed.

8. Date of completion: Indefinite.

9. Assignment: A. R. Croft.

RI - INT
STREAM FLOW
Herbaceous Cover
Idaho

March 15, 1940

STREAM FLOW (BUNCHGRASS GRANITIC SOIL RANGE, IDAHO)

1. Field division: Forest and range influences.

2. Work project: Influence of natural vegetation on stream flow.

3. Line project: Grassland: Role of grassland in influencing stream behavior.

4. Purpose: To determine for bunchgrass granitic soil range lands of southern Idaho, the management practices required for obtaining plant and soil conditions that will yield maximum quantities of usable stream flow.

5. Review of past work: Surveys have shown abnormally rapid run-off of silt-laden water to be due to depletion of the perennial bunchgrass cover on range lands. Subsequent detailed studies have shown that infiltration decreases and surface run-off increases with, (a) degree of plant cover depletion, and (b) organic matter losses from the surface soil, suggesting that maximum yields of ground water can be obtained by maintaining bunchgrass cover on the range. In 1935 two 10-acre, and in 1937 three 200-acre watersheds were equipped with run-off measuring devices and studies were begun for determining the extent to which range use and concomitant changes in the plant soil mantle influence run-off relationships.

6. Accomplishment during past year: The five watersheds were maintained in operation and a detailed base map of the Arrowrock triplicate watersheds was constructed.

7. Plans for next year: (a) Continue operation of watershed, (b) prepare plant and soil inventory of Arrowrock triplicate watersheds.

8. Date of completion: Indefinite.

9. Assignment: George W. Craddock and _____.

RI - INT
WATER UTILIZATION
Herbaceous Cover
Idaho

March 15, 1940

WATER UTILIZATION BY VEGETATION (GRANITIC SOILS, IDAHO)

1. Field division: Forest and range influences.

2. Work project: Water utilization by vegetation.

3. Line project: Range forage: Relation of water requirements of range forage species.

4. Purpose: To determine on the bunchgrass granitic soil range lands of southern Idaho, the kind of range cover that is required for minimizing evapo-transpiration water losses.

5. Review of past work: The climax, perennial bunchgrass cover type has been found to be more effective in inducing infiltration and preventing erosion than secondary-weed and annual-weed successional stages; but relative evapo-transpiration losses of areas in these successional stages is not known. A battery of six 2-milacre steel lysimeters was installed at the Bannock Creek substation in 1932. In 1937 two each of the lysimeters were planted to plants of climax, secondary-weed, and annual-weed successional stages. Some difficulty has been encountered in getting the desired composition and density of plants established on the respective lysimeters, but it is expected that further plantings will solve this problem. A recent analysis of the 4-year record since 1935 shows that the 4-foot profiles of homogeneous granitic soil have yielded very nearly 50 percent of the total precipitation as seepage flow. Surface run-off has amounted to less than 1 percent. Nearly all of the yield occurs during and shortly after the spring thaw. The installation has not been in operation long enough to indicate the affect of plant cover on evapo-transpiration losses.

6. Accomplishments during past year: The lysimeter battery has been maintained in operation, certain species were replanted in some of the lysimeters, and the automatic recording switches were improved and placed in the 12 collecting tanks for a period of practical test. The lysimeter installation was further improved by constructing a rock-concrete retaining wall between the lysimeters and the run-off collecting tanks.

7. Plans for next year: (a) Maintain lysimeter battery in operation; (b) replant to extent necessary to establish desired composition and density of plants; and (c) install custom-built switches providing current tests prove the trial switches to be satisfactory.

8. Date of completion: Indefinite.

9. Assignment: George W. Craddock and _____.

March 15, 1940

WATER UTILIZATION BY VEGETATION (BRUSH AND CHAPARRAL, UTAH)

1. Field division: Forest and range influences.

2. Work project: Water utilization by vegetation.

3. Line project: Brush and chaparral (consumptive use of water by brush and chaparral.)

4. Purpose: To determine for brush and chaparral species the influence of consumptive use of water on stream flow.

5. Review of past work: Past work consists of a study of methods by which the consumptive use of water by plants *in situ* could be made. The plan adopted is based on soil-moisture studies, involving (1) determination of soil moisture to the approximate root zone when leafing begins, (2) soil-moisture recharge during the growing season, (3) measurement of soil moisture when leaves fall. Rapid methods of soil-moisture determination such as soil moisture sampling pits, electrical conductivity, and tensiometers are now undergoing laboratory tests.

6. Accomplishments during past year: As noted under 5.

7. Plans for next year: Install at least one north-and one south-facing plot (*in situ* lysimeter) on Wasatch Stream Flow Laboratory.

8. Date of completion: Indefinite.

9. Assignment: A. R. Croft.

RI - INT
SOIL STABILIZATION
Watersheds
Great Basin

March 15, 1940

SOIL STABILIZATION (FOREST, BRUSH, GRASSLAND, UTAH)

1. Field division: Forest and range influences.

2. Work project: Stabilization of soil.

3. Line project: Watersheds: Relation of forest, brush, grassland cover and management practices to erosion, and soil stability and quality and usability of stream flow.

4. Purpose: To determine on watersheds and plots (1) management practices which will maintain soil stability and normal stream flow; and (2) methods for rehabilitating depleted soil and yield of water.

5. Review of past work: Extensive observational and limited research data indicate excessive accelerated erosion throughout the region, on mixed forest, brush, and grasslands, often seriously affecting quality of water yield. Data from small watersheds and plots, together with extensive observations, indicate that plant cover is the key to the erosion situation. Methods have been developed to determine qualitative and quantitative soil losses produced by accelerated erosion. Soil analyses of approximately 2,000 permanent plots covering all study areas, and of about 2,000 plots along 175 miles of transect covering 21 other localities have been made. Accelerated erosion reduces organic matter, total nitrogen, and moisture equivalent as much as 70, 39, and 67 percent, respectively. Methods for qualitative and quantitative determinations of accelerated erosion have been refined. A soil survey of 5 experimental watersheds involving permanent locating and marking 1,400 plots and securing 2,800 composite soil samples has been made.

6. Accomplishments during past year: Progress has been made toward laboratory analysis of soils from 6 north-facing experimental watersheds at Wasatch Stream Flow Laboratory.

7. Plans for next year: Locate permanent sampling plots and conduct soil survey of 5 south-facing experimental watersheds at Wasatch Stream Flow Laboratory.

8. Date of completion: Indefinite.

9. Assignment: A. R. Croft.

RI - INT
SOIL STABILIZATION
Watersheds
Idaho

March 15, 1940

SOIL STABILIZATION (BUNCHGRASS GRANITIC SOIL RANGE, IDAHO)

1. Field division: Forest and range influences.

2. Work project: Stabilization of soils.

3. Line project: Watersheds: Relation of forest, brush, grassland cover, and management practices to erosion and soil stability and to quality and usability of water.

4. Purpose: To determine on bunchgrass granitic soil range lands of southern Idaho: (1) the range utilization practices required for maintaining soils in place, and (2) the improvement measures needed to stabilize soil on eroding areas.

5. Review of past work: Surveys show that serious accelerated erosion is widespread on range lands of southern Idaho. Detailed studies indicate that erosion increases with cover depletion, steepness of slope, soil disturbance, and rainfall intensity. Restoration of perennial bunchgrass cover is desirable, but adverse climatic, soil, and use factors make natural revegetation extremely slow and uncertain. In 1935 two 10-acre watersheds were fenced and equipped with run-off and erosion-measuring devices in order to determine the effects of range use upon erosion. In 1937 three 200-acre watersheds were equipped with stream-flow gages, but erosion measuring devices have not yet been installed. Intensive erosion control studies were initiated at Arrowrock substation in 1937 and as a result a cooperative demonstration program consisting mainly of contour drilling of grasses, contour furrowing, gully plantings of shrubs, and exclusion of grazing, was extended to about 500 acres of the watershed during 1937 and 1938. These demonstrations are arousing considerable interest among water users and stockmen in southern Idaho.

6. Accomplishments during past year: A study was made on the three 200-acre watersheds at Arrowrock substation to determine the infiltration characteristics of the five main cover types represented on the areas. Analysis of the data is under way.

7. Plans for next year: (a) Test, with the portable rainmaker, the effectiveness of contour seeding in controlling erosion, if seedling establishment is sufficient to warrant these tests. (b) Supplement the 1939 infiltration study on the three 200-acre watersheds, if analysis of data indicates that further studies are needed. (c) Devise satisfactory means of measuring erosion on the 200-acre watersheds. (d) Maintain erosion records on the 10-acre watersheds at Bannock Creek.

8. Date of completion: Indefinite.

9. Assignment: George W. Craddock and _____.

RI - INT
FLOOD CONTROL
Watershed Survey

March 15, 1940

FLOOD CONTROL PRELIMINARY EXAMINATION AND REPORTS (UPPER SNAKE RIVER)

1. Field division: Flood control surveys.

2. Work project: Flood control surveys.

3. Line project: Preliminary examinations: Examination of watersheds to determine existence of flood problems.

4. Purpose: To determine the existence of flood problems and the need for and character and cost of a detailed flood control survey on areas within the Upper Snake River drainage basin.

5. Review of past work: Field work completed for a preliminary report on the Snake River and its tributaries in Wyoming. Participation in Flood Control public hearings covering all major tributaries within the Snake River drainage basin.

6. Accomplishments during the past year: Completed rough draft report on the Weiser River watershed.

7. Plans for next year: Complete preliminary report upon Weiser, Upper Snake (above Idaho Falls), and Payette Rivers, and prepare survey work outline for the Weiser River watershed.

8. Date of completion: 1941.

9. Assignment: Field Coordinating Committee 17B:

Reed W. Bailey, Chairman (FS)
J. H. Christ (SCS)
H. E. Selby (BAE)

Field Working Committee:

George W. Craddock, Chairman (FS)
H. M. Wanser (SCS)
Leonard M. Hill (BAE)

Forest Service Supervision Staff:

Cleve H. Milligan and H. H. Price.

RI - INT
FLOOD CONTROL
Watershed Survey

March 15, 1940

FLOOD CONTROL PRELIMINARY EXAMINATIONS AND REPORT (BONNEVILLE LAKE BASIN AND UPPER COLORADO RIVER)

1. Field division: Flood control surveys.

2. Work project: Flood control surveys.

3. Line project: Preliminary examinations: Examination of watersheds to determine existence of flood problems.

4. Purpose: To determine the existence of flood problems and the need for and character and cost of detailed flood control surveys on areas within the Bonneville Lake Basin of the Great Basin and the Upper Colorado River drainage basins.

5. Review of past work: Field work completed on the Upper Green River and its tributaries in Wyoming. Participation in flood control public hearings covering all major tributaries of the Bonneville Basin and Upper Colorado River drainage basin.

6. Accomplishments during the past year: Submitted preliminary examination report and survey work outline for the Sevier Lake watershed, and rough draft preliminary examination report for the Great Salt Lake watershed.

7. Plans for next year: Complete preliminary report and a survey work outline for the Great Salt Lake watershed and a preliminary examination report upon the Weber River; and participate in preparation of reports upon the Virgin, the Price-San Rafael, and the Upper Colorado (above junction with Green) Rivers.

8. Date of completion: 1941.

9. Assignment: Field Coordinating Committee 17A:

Reed W. Bailey, Chairman (FS)
H. G. Calkins (SCS)
H. E. Selby (BAE)

Field Working Committee:

George W. Craddock, Chairman (FS)
Arthur Fife (SCS)
Leonard M. Hill (BAE)

Forest Service Supervision Staff:

Cleve H. Milligan and H. H. Price.

RI - INT
FLOOD CONTROL
Watershed Surveys

March 15, 1940

FLOOD CONTROL PRELIMINARY EXAMINATIONS AND REPORT (HUMBOLDT RIVER)

1. Field division: Flood control surveys.

2. Work project: Flood control surveys.

3. Line project: Preliminary examinations: Examination of watersheds to determine existence of flood problem.

4. Purpose: To determine the existence of flood problems and the need for and character and cost of detailed flood control surveys on areas within the Humboldt River watershed of the Great Basin drainage basin.

5. Review of past work: Participation in flood control public hearings on the Humboldt River and other tributaries of the drainage basin.

6. Accomplishments during past year: No work on this area.

7. Plans for next year: Initiate report upon the Humboldt River.

8. Date of completion: 1941.

9. Assignment: Field Coordinating Committee 17C:

Reed W. Bailey, Chairman (FS)
Harry Reddick (SCS)
H. E. Selby (BAE)

Field Working Committee:

George W. Craddock, Chairman (FS)
_____, (SCS)
Leonard M. Hill (BAE)

Forest Service Supervision Staff:

Cleve H. Milligan and H. H. Price.

RI - INT
FLOOD CONTROL
Watershed Surveys

March 15, 1940

SEVIER LAKE WATERSHED SURVEY

1. Field division: Flood control surveys.

2. Work project: Flood control surveys.

3. Line project: Watershed surveys: Detailed survey of approved watersheds for preparing action program.

4. Purpose: To determine the kind, cost, and benefits of measures needed to be applied for flood control, water flow retardation and prevention of soil erosion on the watershed lands of the Sevier Lake drainage basin, Utah.

5. Review of past work: New project.

6. Accomplishments during past year: Submitted preliminary examination report and survey work outline in 1939.

7. Plans for next year: Conduct survey.

8. Date of completion: 1941.

9. Assignment: Field Coordinating Committee 17A:

Reed W. Bailey, Chairman (FS)
H. G. Calkins, (SCS)
H. E. Selby (BAE)

Field Working Committee:

George W. Craddock, Chairman (FS)
Arthur Fife (SCS)
Leonard M. Hill (BAE)

Project Leader: _____

RI - INT
FLOOD CONTROL
Watershed Surveys

March 15, 1940

BOISE RIVER WATERSHED SURVEY

1. Field division: Flood control surveys.

2. Work project: Flood control surveys.

3. Line project: Watershed surveys: Detailed survey of approved watersheds for preparing action program.

4. Purpose: To determine the kind, cost, and benefits of measures needed to be applied for flood control, water flow retardation, and prevention of soil erosion on the watershed lands of the Boise River, Idaho.

5. Review of past work: Interim report completed covering recommendations for application of remedial measures on Willow Creek Work Unit, comprising 3 percent of the watershed.

6. Accomplishments during the past year: Completed all field work and initiated the analysis of data and started preparation of a final report.

7. Plans for next year: Complete survey report.

8. Date of completion: March 15, 1940.

9. Assignment: Field Coordinating Committee 17B:

Reed W. Bailey, Chairman (FS)
J. H. Christ (SCS)
H. E. Selby (BAE)

Field Working Committee:

George W. Craddock, Chairman (FS)
H. M. Wanser (SCS)
Leonard M. Hill (BAE)

Project Leader: Thomas H. Van Meter (FS)

APPENDIX

PUBLICATIONS

I. Publications during the calendar year 1939

A. Departmental publications

Costello, David F., and Price, Raymond. Weather and plant-development data as determinants of grazing periods on mountain range. USDA Tech. Bul. 686, 30 pp., illus. 1939.

Stewart, George, Walker, R. H., and Price, Raymond. Reseeding range lands of the Intermountain region. USDA Farmers' Bul. 1823. 25 pp., illus. 1939.

B. Outside publications (in scientific and professional journals, etc.)

Bailey, Reed W. The role of range management in erosion control. Idaho Forester, pp. 9, 38, illus. 1939.

_____ Resource management: A cardinal enterprise in the Intermountain region. South. Idaho Forester, pp. 21-22, 1939.

Maki, T. Ewald. Behold our land, and To hold this soil. Reviews. Jour. Forestry, v. 37, no. 5. 1939.

Saunderson, Mont H. Room on the range. Land Policy Review, July-August 1939.

_____. Systematic records and accounts for managing the western stock ranch. Amer. Cattle Prod., November 1939.

_____. Some economic aspects of the upland watershed lands of the western United States. Jour. Land and Pub. Util. Econ. November 1939. pp. 480-82.

Stewart, George and Young, A. E. The hazard of basing permanent grazing capacity on Bromus tectorum. Amer. Soc. Agron. Jour. 31: 1002-1015, illus. 1939.

C. Miscellaneous mimeographed reports

Flood Control Survey. Preliminary examination report. Run-off and waterflow retardation and soil erosion prevention for flood control purposes, Sevier Lake Watershed, Great Basin, Utah. November 19, 1939. 28 pp.

Saunderson, Mont H. A comparison of the costs of trucking and trailing lambs from summer range to shipping point. 1939.

_____, and Favre, C. E. Some economic aspects of the size of range livestock enterprises and the size of grazing permits on the public lands of the Intermountain region. 1939.

II. Manuscripts intended for departmental publication between January 1, 1940 and June 30, 1941.

Clark, Ira and _____. Range-use indicators and utilization standards for Intermountain range lands. USDA Farmers' Bul. 25 pp., illus.

Ellison, Lincoln. A comparison of methods of quadratting shortgrass vegetation. Jour. Agr. Res. 20 pp., 6 illus.*

Hutchings, Selar S., and George Stewart. Palatability and utilization of desert vegetation as influenced by climate, season of use, and composition of plant cover. Jour. Agr. Res. 20 pp., 6 illus.

McCarty, E. C., and Price, Raymond. Growth and carbohydrate food ratios of important range forage plants and their reactions to clipping and grazing treatments. USDA Tech. Bul. 70 pp., 15 illus.

Maki, T. Ewald. Collection, extraction, and testing of ponderosa pine seed. USDA Tech. Bul. 45 pp., 10 illus.

Mowat, Edwin L. Seed production by various sizes and classes of ponderosa pine trees in Idaho. Jour. Agr. Res. 12 pp., 5 illus.

Plummer, A. Perry. Viability, rate of germination, and early development of twelve important range grasses. Jour. Agr. Res. 5 pp., 2 illus.

Saunderson, Mont H., and Roth, Arthur H. Jr. An area economic study of public land grazing use in central Utah. USDA Bul. 40 pp.

Stewart, George, Cottam, W. P., and Hutchings, Selar S. Influence of unrestricted grazing on northern salt desert plant associations in western Utah. Jour. Agr. Res.

_____, and Hutchings, Selar S. Improvement of winter ranges as influenced by season and intensity of grazing. USDA Tech. Bul. 32 pp., 10 illus.

_____, Pickford, G. D., and Pechanec, Joseph F. Effect of sagebrush removal by fire on native spring-fall range in southeastern Idaho. USDA Tech. Bul. 30 pp. 12 illus.

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* Field work done at Northern Rocky Mountain Forest and Range Experiment Station.

III. Manuscripts and articles proposed for outside publication.

Clark, Ira. Use of volume-height tables in estimating degree of forage utilization. Amer. Soc. Agron. Jour.

Craddock, George W. Forestery and water. Jour. Forestry.

Harris, J. A., and Stewart, George. Plant sap properties and their relation to environmental conditions. Ecology.

Hull, A. C. Jr. Hand machines facilitate seed collection of range species. Jour. Forestry.

_____. Bulbous bluegrass. Its value on Intermountain ranges. Amer. Cattle Prod.

_____., and Shaw, Seth T. Respiration of Poa bulbosa. Utah Acad. Sci., Arts and Letters Proc.

_____ and Stewart, George. Bulbous bluegrass on the foothill ranges of Utah. Amer. Soc. Agron. Jour.

Hutchings, Selar S. New method of coordinate mapping low shrubs. Amer. Soc. Agron. Jour.

Maki, T. Ewald. Significance and applicability of seed maturity indices for ponderosa pine. Jour. Forestry.

_____. Branching habit and rate of natural pruning in second growth ponderosa pine. Jour. Forestry.

_____ and Mowat, Edwin L. Some physical and chemical characteristics of granitic soils in central Idaho. Soil Sci.

_____ and Mowat, Edwin L. The relation of snow storage to plant cover and other factors within the ponderosa pine type. Jour. Forestry.

Mowat, Edwin L. Damage by logging and slash disposal in Idaho ponderosa pine. Jour. Forestry.

_____. Results of selective cutting in ponderosa pine forests of central Idaho. Jour. Forestry.

Pearse, C. Kenneth. Soil factors influencing the infiltration rate of range soils of the Intermountain region. Soil Sci.

_____ and Friedrich, C. Allan. Effective methods of reseeding steep range lands devised. Natl. Wool Grower.

_____ and Hull, A. C. Range reseeding - is it economically sound? Amer. Cattle Prod.

Pechanec, Joseph F. Sampling error in surveys on sagebrush-grass range. Jour. Forestry.

_____. Range research seminar. Ecology.

_____ and Stewart, George. Sampling problems on sagebrush wheatgrass ranges. Amer. Soc. Agron. Jour.

_____ and Stewart, George. Personal error in the estimation of weight and methods for its control and reduction. Amer. Soc. Agron. Jour.

Roth, Arthur H. Jr. A graphic summary of grazing on the public lands of the Intermountain region. Mimeographed, in three parts.

Saunderson, Mont H. Some economic aspects of western range land conservation. Jour. Forestry.

_____. Land costs and investment standards for range sheep production. Natl. Wool Grower.

_____. Studies in area management for the western public lands. Land Policy Review.

_____, and Roth, Arthur H. Jr. Range sheep production and land use in Utah and Idaho. Natl. Wool Grower.

Stewart, George. Forest service range research seminar. Amer. Soc. Agron. Jour.

_____ and Hull, A. C. Jr. Grass reseeding on mountainous summer ranges and watersheds. Amer. Soc. Agron. Jour. 12 pp.

Walker, R. H., Klingebiel, A. A., and Stewart, George. Intensity of nitrification in range soils of the Intermountain region. Soil Sci.

STATION PERSONNEL - C.Y. 1939

ADMINISTRATION

Regular

Reed W. Bailey	Director
Walter E. Mann	Adm. Assistant
Marguerite A. Israelson	Clerk
Herbert Burrell	Clerk
Leona H. O'Donnell	Asst. Clerk
Hazel Brown	Sr. Stenographer
Signe Ruh Otterson	Jr. Librarian (Coop. R-4)

Temporary

Zura Gerdicia	Sr. Stenographer
Buster Williams	Under Clerk
Yvonne Porter	Junior Typist

RANGE INVESTIGATIONS

Grazing Management

Regular

George Stewart	Sr. Forest Ecologist
Lincoln Ellison	Range Examiner
Joseph F. Pechanec	Assoc. Forest Ecologist
Selar S. Hutchings	Asst. Forest Ecologist
Ira Clark	Asst. Conservationist.

Temporary

Harold E. Gibson	Jr. Field Assistant
John W. Quayle	Jr. Field Assistant
Eldon Earl Meik	Under Asst. Tech.
Paul E. Hansen	Jr. Field Assistant
Richard A. Hougland	Jr. Field Assistant
Hosmer Ray Bjarnson	Under Asst. Tech.
Richard M. Hurd	Jr. Field Assistant
Charles M. Poulton	Jr. Field Assistant
Virgil Peterson	Jr. Field Assistant

Artificial Reseeding

Regular

George Stewart	Sr. Forest Ecologist
C. Kenneth Pearse	Conservationist
Alvin C. Hull	Jr. Range Examiner
Arthur Perry Plummer	Jr. Range Examiner

Temporary

Grant Harris	Jr. Field Assistant
Paul E. Packer	Jr. Field Assistant
W. Harold Hirst	Asst. Technician.

FOREST ECONOMICS

Range Economics

Regular

Mont H. Saunderson	Sr. Economist
Arthur H. Roth	Asst. Economist

Temporary

Durrell E. Evans	Under Field Assistant
Richard Roylance	Under Field Assistant
Morris H. Taylor	Asst. Field Assistant

FOREST MANAGEMENT RESEARCH

Silviculture

Regular

T. Ewald Maki	Assoc. Forester
Edwin L. Mowat	Asst. Silviculturist

Temporary

Edmund L. Barraclough	Minor Asst. Tech.
Charles F. Smith	Jr. Asst. Tech.
William B. Ogg	Jr. Field Assistant

FOREST AND RANGE INFLUENCES

Influence of Natural Vegetation on Stream Flow

Regular

George W. Craddock	Sr. Range Examiner
A. Russell Croft	Conservationist
Lowell Woodward	Jr. Range Examiner
James P. Thorne	Junior Technologist

Temporary

Howard R. Foulger	Asst. Field Assistant
Harry W. Pledger	Foreman C&M
Richard B. Marston	Under Field Assistant
Donald F. Hervey	Under Field Assistant
Oliver Cliff	Under Field Assistant
Neil Wilcox	Under Asst. Tech.
A. Riggs Murdock	Assistant Technician
C. Allan Friedrich	Asst. Technician
Robert W. Ferebauer	Asst. Eng. Aide

FLOOD CONTROL SURVEYS

Preliminary Examinations

Regular

Reed W. Bailey	Director
George W. Craddock	Sr. Range Examiner
Cleve H. Milligan	Assoc. Hydraulic Eng.
Harold H. Price	Assoc. Range Examiner
Byron F. Thurmond	Prin. Eng. Draftsman

Boise River Survey

Regular

Reed W. Bailey	Director
George W. Craddock	Sr. Range Examiner
Thomas H. Van Meter	Forester
Kenneth M. Daniels	Forest Ranger
Keith M. Walker	Clerk

Temporary

George L. Ballinger	Asst. Topographic Drafts.
Jessie Budge	Jr. Clerk Stenographer
Ila B. Droz	Jr. Clerk Stenographer
Agnes M. Medvit	Jr. Clerk Stenographer
William B. Meister	Sr. Engineering Drafts.
Annette J. Mihelich	Jr. Clerk Stenographer
Earl LeRoy Smith	Jr. Civil Engineer
Gertrude A. Stringer	Jr. Clerk Stenographer
Marshall K. Wood	Jr. Range Examiner
J. Marvin Rosa	Jr. Civil Engineer
John S. Crawford	Asst. Eng. Aide
Irving J. Feinberg	Asst. Eng. Aide
John E. Moats	Field Assistant
Paul F. Parrish	Asst. Eng. Aide
Frances B. Allen	Jr. Clerk Stenographer
H. Walter Dahl	Asst. Eng. Drafts.
Dudley Munns	Under Field Asst.

FINANCIAL BUDGET OF CURRENT FISCAL YEAR FOR PROJECTS

1. Direct & indirect costs by division

Division	Indirect project costs (overhead)	Direct project costs	Total costs
Forest Management	$ 250	$ 7,150	$ 7,400
Range Investigations	9,572	54,028	63,600
Forest Economics	1,910	11,590	13,500
Forest & Range Influences	1,670	14,080	15,750
Flood Control Surveys	7,720	61,884	69,604
P&M Improvement, R-4	-	3,200	3,200
TOTALS	21,122	151,932	173,054

2. Distribution of direct costs by main projects

Division and Work Project	Cars maintenances & new	Scientific equipment & project supplies	Travel expenses other than cars	Salaries		Total
				Regular	Temporary	
FOREST MANAGEMENT						
Silviculture	$ 200	$ 620	$ 300	$ 5,900	$ 380	$ 7,400
RANGE INVESTIGATIONS						
Grazing Management	2,500	3,437	790	18,806	5,285	30,818
Artificial Reseeding	1,750	6,698	1,100	17,644	5,590	32,782
FOREST ECONOMICS						
Range Economics	300	883	1,000	9,052	2,265	13,500
FOREST INFLUENCES						
Water Behavior and Run-off	2,000	1,139	500	9,096	3,015	15,750
FLOOD CONTROL SURVEYS						
Supervisory & Preliminary	600	2,140	1,700	12,460	3,100	20,000
Boise River Survey	2,900	6,542	5,500	24,105	10,557	49,604
TOTALS	10,250	21,459	10,890	97,063	30,192	169,854